IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF WEST VIRGINIA
AT CHARLESTON

THE CITY OF HUNTINGTON,	:	Civil Action
Plaintiff,	:	No. 3:17-cv-01362
v.	:	
AMERISOURCEBERGEN DRUG CORPORATION, et al.,	:	
Defendants.	:	
CABELL COUNTY COMMISSION,	:	Civil Action
Plaintiff,	:	No. 3:17-cv-01665
v.	:	
AMERISOURCEBERGEN DRUG CORPORATION, et al.,	:	
Defendants.	:	

BENCH TRIAL - VOLUME 36
BEFORE THE HONORABLE DAVID A. FABER, SENIOR STATUS JUDGE
UNITED STATES DISTRICT COURT
IN CHARLESTON, WEST VIRGINIA

JULY 8, 2021

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Proceedings recorded by mechanical stenography;
transcript produced by computer.

PROCEEDINGS had before The Honorable David A. Faber, Senior Status Judge, United States District Court, Southern District of West Virginia, in Charleston, West Virginia, on July 8, 2021, at 9:00 a.m., as follows:

THE COURT: Good morning, everybody.

Dr. Hughes, are you in the courtroom?

THE WITNESS: I am, sir.

THE COURT: You may resume the stand.

JAMES W. HUGHES, DEFENDANTS' WITNESS, RESUMED THE WITNESS STAND

THE COURT: Good morning, sir.

THE WITNESS: Good morning, Your Honor.

THE COURT: All right, Mr. Majestro, you may proceed.

MR. MAJESTRO: Thank you, Your Honor.

CROSS EXAMINATION

BY MR. MAJESTRO:

Q. Dr. Hughes, when did payers start paying attention to the number of opioid prescriptions written in West Virginia?

A. It seems it was -- really got serious about 2016, 2017.

Q. And that was because they were seeing a large increase in those prescriptions; correct?

A. Yes, I believe that's correct.

Q. And those -- that number of pills was a red flag that

caused them to rethink their coverage; correct?

A. That certainly would be part of it, but also I think in that time period there was the CDC guidelines that were introduced that had a big effect on payers' behavior.

Q. Okay. Let's go back and, and talk a little bit about your experience.

You've been a testifying expert witness for the pharmaceutical industry for 20 years; is that correct?

A. 20, 25 years.

Q. Okay. And, in addition, you've done consulting work for 10, 15 pharmaceutical companies outside of litigation; correct?

A. Excuse me. Could you say that again?

Q. You've done additional consulting work for, for the pharmaceutical industry; correct?

A. Outside of expert witness work?

Q. Yes.

A. No, sir.

Q. Okay. How many cases have you served as an expert witness?

A. In total, it's between 30 and 40.

Q. And it's true that all but two of those you served as an expert for the defense; correct?

A. Yes, that sounds correct.

Q. And you've never published any peer-reviewed studies

about the pharmaceutical industry, prescription drug markets, distributors, or opioids; correct?

A. That's correct. None of the work I do as an expert is publishable because of confidentiality.

Q. And your work in this area has been only as a paid expert, then, correct, for industry?

A. I'm sorry?

Q. Your work in this area has been only as a paid expert for industry; correct?

A. Yes, that's correct.

Q. So the report and testimony that -- the report you issued in this case and the testimony you've given doesn't address any of the plaintiffs' experts; correct?

A. That's correct. I did not review any of the plaintiff expert reports.

Q. You've never been to Cabell County or Huntington, West Virginia; correct?

A. I grew up in Pittsburgh and we were in West Virginia a lot. Probably. But if I was, I don't remember.

Q. Okay. Since childhood?

A. Since childhood is fair to say, yes.

Q. So the, the time period where the opioid epidemic has, has blossomed, you've not been to Huntington or Cabell County?

A. That's correct, sir.

Q. And you're not familiar with the breakdown of payers for prescription drugs in Cabell or Huntington; correct?

A. That's correct. We looked very hard for that type of information and we were not able to find it broken down by county in West Virginia.

Q. Okay. So in this case, as you made pretty clear yesterday, your, your focus is on the payers. Is it fair to say you're basically saying that payers have tools to reduce the use of opioids?

A. Yes, they do.

Q. And, essentially, now payers are reducing the supply of opioids through the control of payment; correct?

A. They have definitely tightened up their controls, that's true.

Q. And that reduction in opioid supply to these patients doesn't require pain to be untreated, does it?

A. I'm sorry, I couldn't hear you. Could you repeat that please?

Q. Sure. The reduction in supply caused by the payers doesn't require the patients' pain to be untreated; correct?

A. That's my understanding, yes.

Q. And that reduction in opioid use by the payer entities are -- those entities are outside the doctor/patient relationship; correct?

A. Well, yeah, from an economic standpoint, they're what's

referred to as a third-party payer. So they are not privy to the, to the discussions between the doctor and the patient.

Q. In your report, you don't offer any opinions regarding whether distributors have tools that also could affect the, the doctor/patient decision to prescribe opioids; correct?

A. That's true. My, my report was confined to payers.

Q. Now, in this case -- and you've never done any work for a distributor prior to the opioid litigation; correct?

A. No, sir. That is -- I'm sorry. It's been 25 years, so I kind of have to go through the list. I'm sorry.

Q. And, so, so, in the past 25 years -- so you said -- I'm sorry. I'm not sure I understood your answer.

A. I said "no."

Q. Okay. In preparing your report, you didn't speak with any of the employees of the distributor defendants in this case; correct?

A. I did not.

Q. You don't cite any of the distributors' documents in your report; correct?

A. That's correct.

Q. You didn't review any data produced by distributors; correct?

A. Excuse me?

Q. You didn't review -- sorry. You didn't review any data

produced by the distributors in this case; correct?
A. Because I'm not hearing "did" or "didn't," but I did not review any data from distributors.
Q. Maybe I'll get a little closer to the mic and see if that helps. And you're not offering opinions on what distributors could have done or should have done to prevent prescriptions from being filled; correct?
A. That's correct.
Q. And you're not aware of what tools distributors could have had access to; correct?
A. That is also correct, yes.
Q. You have no opinion whether they had -- do you know what IMS data is? IMS data?
A. Yes, sir. But I believe now it's called IQVIA.
Q. It is.
A. Okay.
Q. So you know what that is?
A. Yes, I do.
Q. You don't have any opinions as to whether the distributors had access to that; correct?
A. I wasn't asked to do anything like that.
Q. Did you look at whether the distributors had access to switch data or claims data?
A. No, sir, I did not.
Q. Or dispensing data?

A. No, sir.

Q. Now, distributors did have access to their own transactional data; correct?

A. That's correct.

Q. And that data would have showed 81 million opiate pills into Cabell County and Huntington; correct?

MR. HESTER: Your Honor, objection. The scope of the witness's testimony on direct was confined to payers. It did not get into the conduct of distributors and we were quite clear that he was not offering opinions related to distributors. So I object as beyond the scope.

THE COURT: Where are you going with this, Mr. Majestro?

MR. MAJESTRO: Well, I guess I wonder what relevance this witness has and we'll get to that later. But this is the last question I have on, on that part.

THE COURT: Okay, overruled. I'll let you ask him the question.

BY MR. MAJESTRO:

Q. So the distributors did have access to transactional data that would have shown 81 million pills shipped into Cabell County and Huntington; correct?

A. I don't know what their data would have shown. I did not review any of their data.

Q. But they would have had access to their own data; correct?

A. Whatever that is, yes, they would have access to their data.

Q. Okay, fair enough. You understand that opioids are controlled substances distributed as part of a closed system where all participants, including the distributors in this case, have to be licensed by the DEA and the State Board of Pharmacy?

MR. HESTER: Again, Your Honor, I object as beyond the scope. We did not get into these issues of the DEA regulations or anything related to these questions of authority that counsel is raising.

THE COURT: Well, this is cross-examination and I'm supposed to give -- allow wide latitude here. So I'll overrule the objection.

You can go ahead, Mr. Majestro.

MR. MAJESTRO: Thank you.

BY MR. MAJESTRO:

Q. Do you need me to repeat the question?

A. Yes, please.

Q. You understand that opioids are controlled substances distributed as part of a closed system where all participants, including the distributors in this case, have to be licensed by the DEA and the State Board of Pharmacy;

correct?

A. I know that opioids are a controlled substance. The rest of it is not something I have at the tip of my tongue.

Q. Fair enough. You're aware that distributors have -- that there are regulations requiring the distributors to take care that controlled substances aren't diverted?

A. Again, I didn't look into anything having to do with distributors. So that could be correct, but I don't have any knowledge of that myself.

Q. And you're -- so, then, you're not offering any opinions as to whether distributors met those duties because you don't know what the duties were; correct?

A. That's correct.

Q. Let's talk about payers. Payers are not part of the closed system for distribution of opioids; correct?

A. Again, I'm not privy to what -- who's involved in the closed system, so I don't know that one way or the other.

Q. So in any of your work, did you come across any testimony or documents or reports or laws that required payers to be licensed by the DEA?

A. I did not see anything like that, no.

Q. Or the State Board of Pharmacy?

A. Correct. I didn't see anything like that.

Q. And do you -- can you testify regarding whether payers have any duties to actively monitor for diversion of

controlled substances?
A. I don't know one way or the other.
Q. But you're not offering any opinions that payers failed to comply with any applicable laws; correct?
A. No, sir. That would be a legal conclusion.
Q. And you're not aware of any conduct that might show that payers might have transgressed any applicable laws in their coverage of opioids?
A. Yeah. That was beyond the scope of what I was asked to do and it would be a legal conclusion I believe.
Q. In your report and testimony, you don't assign any fault for the opioid epidemic to payers; correct?
A. I believe in my deposition I referred to it as a contributing factor, but fault, no. Fault as a legal concept certainly, no.
Q. Okay. And, so, you have no knowledge of whether payers had any duty, so you can't say they were at fault?
A. Correct.
Q. And nowhere in your report or your testimony do you opine that payers' access to data absolves distributors of potential fault related to the opioid epidemic?
A. Yeah, that's beyond the scope of my assignment I believe.
Q. So you're an economist; correct?
A. That's correct.

Q. Economists commonly perform quantitative analysis; correct?

A. Theoretical and quantitative analysis, yes.

Q. Can you explain to the Court what quantitative analysis is?

A. Basically, quantitative analysis is generally considered to be the analyses of data using statistical tools.

Q. And in this case, you did not perform any quantitative analysis; correct?

A. That's correct. And as I said yesterday, I didn't think it was necessary given all of the other evidence that was available to me.

Q. You didn't attempt to quantify how many fewer pills, if any, would have been shipped to Cabell and Huntington if payers had acted differently; correct?

A. That's correct. I performed no such analysis.

Q. You didn't calculate or measure the extent to which payers could have theoretically lessened the epidemic by using tools to control opioid prescribing; correct?

A. No, I did not have the data and was not asked to do that.

Q. And you're not aware of anyone else that has done that analysis for Cabell and Huntington; correct?

A. I'm not aware of anyone else, that's correct.

Q. You're not opining that payers' systems were designed to detect diversion or abuse of controlled substances; correct?

A. No, I -- sorry. No.

Q. And, in fact, payer systems are primarily motivated by decreasing cost, not preventing addiction and diversion; correct?

A. Well, I think it's a little more complicated than that. Certainly, the tools that I talked about yesterday, prior authorization and step therapy and quantity limits, certainly had their genesis back in the '80s in terms of controlling.

But, certainly, in the post-2010 and post-2016-2017 period, these tools have been used, I believe, for clinical reasons to reduce opioid dispensing for clinical reasons as opposed to only cost control.

Q. So in essence, though, without quantitative analysis, you would be speculating as to what would have happened in the alternative universe where payers adopted these controls earlier?

A. Oh, I don't believe so. I believe the, the academic literature and testimony of, of the Medicaid representatives is very clear that prior authorization and step therapy and these tools are effective and, by extension, would have been effective at any time they were imposed.

Q. Those tools were being used -- initiated while other regulatory and legal and standard of care changes were happening at the same time; correct?

A. Yes.

Q. So you can't, you can't identify those changes on any causative basis because you have not done quantitative analysis on those changes?

A. Well, to the extent that the changes in these rules, the changes in these tools were in response to changes in the standard of care, for example, the CDC guidelines, along with other reports and other research that the, that the payers did, I think from a statistical standpoint it would be very difficult to disentangle because the change in the tools happened because of the change in the standard of care.

So I think statistically it wouldn't be possible to separate out how much of it was the tool and how much of it was the change in the standard of care.

Q. Fair enough. And you can't do that sitting here today on the stand?

A. No, sir.

Q. Payers cannot directly impact cash customers; correct?

A. Directly, no, but academic research shows that indirectly it can affect cash customers.

Q. And four and a quarter percent of West Virginia

prescriptions are cash? Did I remember that correctly from yesterday?

A. Yes, sir, I believe so.

Q. What percent of opioid prescriptions are cash?

A. We did not have access to data for that. Given -- as I said yesterday, given Medicaid expansion, I would expect it to be about the same. But I don't have -- I did not -- I was not able to find any data to that question.

Q. And you don't have any data on what percentage of diverted opioid prescriptions were paid for by cash, do you?

A. That's correct.

Q. Were you aware that the DEA considers cash payments a red flag for diversion?

A. No, sir. That was outside the scope of my assignment.

Q. And were you aware that where you have high diversion, you have a high percentage of cash payments?

A. Again, that was outside the scope of my assignment.

Q. You have no knowledge of like pill mill pharmacies or pill mill doctors?

A. That was not anything that I looked at, no, sir.

Q. In this case we've heard evidence of a pharmacy, SafeScript, with more than 80 percent of prescription opioids paid for in cash. Payer actions would have had limited impact on this pharmacy; correct?

MR. HESTER: Your Honor, I object to lack of

foundation and also well beyond the scope of the direct.

THE COURT: Well, overruled. I'll let him answer.

BY MR. MAJESTRO:

Q. You can answer, Doctor.

A. I'm sorry?

Q. The Judge said you can answer.

A. Oh, I'm sorry, sir. I didn't hear you. Could you repeat it, please?

Q. Sure. Payer actions -- well, let me follow up. We've heard evidence of a pharmacy, SafeScript Pharmacy in Huntington, with more than 80 percent of prescription opioids paid for in cash. Payer actions would have had limited impact on this pharmacy; correct?

MR. NICHOLAS: Your Honor, I will object. I don't believe that was the testimony. There's no foundation for that and that's inaccurate. So I object on that basis.

THE COURT: Well, I'm going to allow it. This relates to the actions of payers and I think it is within the scope and --

MR. MAJESTRO: And Mr. Farrell corrected me that it's 86 percent of control versus non-control. That was the testimony. I stand corrected.

BY MR. MAJESTRO:

Q. So the question is that payer actions at a pharmacy that is being -- where the customers are substantially

predominantly paying in cash would have limited impact; correct?

A. I think that's an open question given that presumably those cash prescriptions were prescriptions that were being written by physicians. And as the standard of care evolved, presumably that would affect the physician writing the prescription.

Q. And that assumption is that those were legitimate prescriptions that were being written for medical, appropriate medical use; correct?

A. I -- I'm sorry. Could you say that again?

Q. I said you're assuming that the prescriptions taken to a pharmacy where 86 percent are paying in cash were written for a legitimate medical purpose?

A. The prescriptions were written by a physician. The purpose I can't speak to.

Q. Yeah. And, and a physician motivated by -- not motivated by a legitimate medical purpose whose customers pay in cash, payer actions would have little impact on them; correct?

A. Yes, I believe that's correct.

Q. In this case, you saw no evidence that distributors ever warned the payers that there was a problem in Cabell and Huntington with too many opioid pills; correct?

A. That was kind of beyond the scope of what I was asked

to do.

Q. You didn't see any evidence in looking at, through the materials you were provided; correct?

A. Well, correct, but that would have been distributor materials and I didn't see any of those.

Q. Payers can share data that doesn't reveal patient HIPAA protected personal information; correct?

A. It's complicated but, yes, they can.

Q. And you saw no evidence that these defendant distributors ever inquired of payers why 81 million opioid pills were distributed by these defendants in Cabell County and Huntington, a city with -- an area with a population of 90,000 people?

A. No, sir. That was beyond the scope of my assignment.

Q. Thank you, Dr. Hughes. That's all I have.

THE COURT: Any other cross?

MS. KEARSE: No, Your Honor.

THE COURT: Any redirect?

MR. HESTER: No questions, Your Honor.

THE COURT: All right. May Dr. Hughes be excused?

(No Response)

THE COURT: Dr. Hughes, thank you, sir, very much. You're free to go.

THE WITNESS: Thank you, Your Honor.

THE COURT: I would have made them finish you

yesterday if I had known it was going to be short. So I apologize for the inconvenience.

THE WITNESS: Nothing could be done. Thank you.

MR. MAJESTRO: I will say that the evening allowed me to improve my outline substantially.

THE COURT: Okay. All right.

MR. MAHADY: Good morning, Your Honor.

THE COURT: Good morning, Mr. Mahady.

MR. MAHADY: AmerisourceBergen is going to call Theodore Martens, retired partner from PwC, as its next witness.

THE COURT: Okay.

MR. MAHADY: He can come in and take the stand.

THE CLERK: Could you please state your full name?

THE WITNESS: Theodore Martens, M-a-r-t-e-n-s.

THE CLERK: Thank you. Please raise your right hand.

THEODORE MARTENS, DEFENDANTS' WITNESS, SWORN

THE CLERK: Thank you. Please take a seat.

DIRECT EXAMINATION

BY MR. MAHADY:

Q. Mr. Martens, good morning.

A. Good morning.

Q. Mr. Martens, can you please introduce yourself to the Court?

A. I'm Ted Martens. I'm a retired PwC. I reside in Demarest, D-e-m-a-r-e-s-t, New Jersey.

Q. Mr. Martens, we're going to come back to your professional background in a second, but I want to start with your educational history.

Can you please describe your educational background to the Court.

A. Bachelor of Science in biology, Fairfield University, and an MBA in accounting, Fairleigh Dickinson University.

Q. Now, while you were obtaining your MBA, were you also working?

A. I was, yes.

Q. And where were you working at the time?

A. At one of the predecessor firms to PwC, Coopers & Lybrand. I joined the audit staff there in 1978.

Q. Okay. Mr. Martens, are you a certified public accountant?

A. I am, yes.

Q. And how long have you been a certified public accountant?

A. Since 1981, licensed in the State of New York.

Q. Okay. At any point in time did you hold temporary licenses anywhere else?

A. I did, yes.

Q. And where was that?

A. In the states of Texas and West Virginia.

Q. Okay. I want to go back to your time at Coopers & Lybrand. Can you please explain to the Court what your role was on the audit staff?

A. As a member of the audit staff, basically being assigned to audits of publicly held companies, their financial statements, and within each staff classification doing different accounts, auditing different accounts and ultimately was admitted to the firm as an audit partner in 1987.

Q. Okay. And as a member of the audit staff and a CPA at the time, did you regularly work with the internal records of large companies?

A. Yes.

Q. And would that include their sales data?

A. Yes.

Q. Okay. Now, at some point did you become a partner?

A. I did in 1987.

Q. Okay. And did you remain in the audit staff after that?

A. Yes. I was assigned to various accounts and was the signing partner in terms of releasing financial statements and signing on behalf of the firm.

Q. Okay. And at any point, did your role change?

A. It did. In 1990 I was asked to start a forensic

accounting practice in the New York office of the firm.

Q. Okay. And can you explain for the Court what forensic accounting is?

A. Forensic accounting is a specialized area of accounting typically -- engagements are -- we were involved in engagements where there's disputes involved and typically retained by counsel to focus in on specific issues at hand, drilling down on those matters and so forth, and then being prepared to analyze the information and provide and assist counsel and the courts at times and so forth under the circumstances.

Q. Okay. And, again, as a forensic accountant, did you work with large datasets?

A. Yes.

Q. And did you analyze large datasets?

A. Yes.

Q. Would you consider yourself a forensic accountant?

A. Yes.

Q. Would you consider yourself an expert in forensic accounting?

A. Yes.

Q. Would you consider yourself an expert in data analytics?

A. Yes.

Q. Okay. At some point did Coopers & Lybrand merge with

another company?

A. Yes. In 1998 Coopers & Lybrand merged with Price Waterhouse to form PricewaterhouseCoopers.

Q. Okay. And, so, you then became a partner at PricewaterhouseCoopers?

A. That's correct.

Q. Okay. And at some point did you retire from PricewaterhouseCoopers?

A. Yes.

Q. When was that?

A. That would have been in 2012. The firm has a mandatory retirement age of age 60. I was extended as an active partner for a year and then retired in 2012.

Q. Okay. So for the period from 2012 to 2019, in many respects you considered -- you continued to work for PwC in a partner-type capacity. Is that fair?

A. Correct. I was extended beyond 2012 for up through July of 2019 in a client, a client consultancy capacity in large part given the significant matters that I was involved in for a period of time.

Q. Okay. And we're going to come back to those matters in a couple minutes. But in your consultancy capacity, did you continue to work with teams at PwC?

A. Correct.

Q. And did those teams help you in analyzing data for the

engagements you were involved in?

A. That's correct. Nothing really, nothing really changed in terms of transitioning from an active partner to functioning in a client consultancy capacity.

Q. Okay. And as both an active partner at PwC for many years in the client consultancy capacity, did you serve as an expert?

A. Yes.

Q. Okay. And did you serve as an expert in matters involving state and federal litigation?

A. That's correct, yes.

Q. Approximately how many times have you served as an expert?

A. Well, if you include the times I've given deposition testimony and along with trial testimony and arbitration testimony, I would say approximately anywhere from 125 to 150 times. That's an estimate.

Q. Are you aware of a court, state/federal, ever precluding you from testifying?

A. No.

Q. Okay. Can you give this Court some examples of matters where you've testified as an expert?

A. I was retained by the State Department in matters or claims brought before the Iran U.S. Claims Tribunal. And I was the lead valuation expert on behalf of the State

Department in what were I'll best describe as non-military asset valuations and testified before the members of the tribunal, a tribunal comprised of nine judges sitting in The Hague, Netherlands, three American judges, three Iranian judges, and then three judges from other countries, and testifying there and providing my opinions with respect to the calculation of how those assets should be valued with respect to claims brought by the Islamic Republic of Iran against this country.

Another matter that comes to mind is the Thomas Petters ponzi scheme. This is one of the largest frauds in the history of this country.

I've testified in countless occasions assisting the trustee in claw back litigations pending, in large part, in court in the Minneapolis, St. Paul area.

In addition to the claw back litigations where the trustee is looking to recover funds from the net winners of the scheme of the fraud, I've also testified in two substantive consolidation trials.

The third matter that comes to mind is the Tobacco Master Litigation -- the Tobacco Master Settlement. And there I worked on that matter from its start, from its inception right up through until -- for the better part of 20 years.

And there the -- that work has -- I've been testifying

with respect to matters that have been brought by non-participating manufacturers, as well as rulings I made over the years as the partner responsible for the firm's role as the independent auditor of that settlement, and those rulings being settled through arbitration per the settlement agreement and testifying at those -- at the arbitration proceedings.

Q. Have you ever served as an expert in matters involving other large accounting firms?

A. Yes.

Q. Can you describe that for the Court, please?

A. Ernst & Young. I was the -- I was their liability expert in the *Ernst & Young* vs. *Cendant* litigation and testified in that matter. It was one of the largest -- at the time, I believe the largest accounts malpractice matters pending.

Q. Okay. Now, in those four matters you just discussed, has that involved large amounts of data?

A. Yes, in all instances, that's correct.

Q. And have you and your team at PwC been tasked with processing and analyzing the data to support your expert work in those matters?

A. Yes.

Q. Okay. Have you ever -- any experience as an expert in cases involving the pharmaceutical industry?

A. Yes.

Q. Can you explain that to the Court?

A. A number of years ago, I was retained by IMS Health to analyze pharmaceutical data. And there, as I recall, it was an intellectual property matter.

Q. Okay. And, Mr. Martens, just so we're clear, you have not analyzed any IMS data in this case; correct?

A. That's correct.

Q. And you're not an expert on IMS data; correct?

A. That's correct.

Q. Okay. Now, in addition to serving in an expert capacity, have you had the opportunity to work with federal and state judges?

A. Yes, I have.

Q. Can you explain that to the Court?

A. I've been a member of the faculty of the National Judicial College. The National Judicial College is located on the campus of the University of Nevada in Reno.

And there I -- as a faculty member, I was an instructor at a program entitled "Financial Statements in the Courtroom." It's a program that's been offered to teach the judges, teach them general accepted accounting principles, financial statement preparation, and then the roles of CPAs in terms of the services provided; auditing those financial statements, preparing reviews, compilations, other forms of

financial information.

I teach the forensic accounting section of the program. I prepare the materials and get into the business evaluation section of the program as well. We -- the program -- most of the time the judges will attend in Reno. Also at times we take the program on the road.

For many years the program was offered through the Federal Judiciary Center for Federal District and Federal Bankruptcy Court judges. We've had probably over the years -- I'd say over the past 25 years or so 6,000 judges attend the program.

Q. Okay. I want to take a slight detour and ask you about a different part of your background. Have you had any military service?

A. Yes.

Q. Okay. And can you explain that for the Court, please?

A. I'm a retired Lieutenant Colonel, New Jersey Army National Guard. I was a combat engineer and officer 30 years.

Q. Okay. And were you working with the -- or serving with the Army National Guard while you were a partner at Coopers & Lybrand and PwC?

A. Yes.

Q. Okay. And can you explain to the Court any of the engagements that you had with the New Jersey National Guard?

A. Well, it was -- you know, in terms of the military, moving up through the chain of command as an officer in the engineer battalion and then as the division engineer on staff at Fort -- it was headquartered at Fort Dix, New Jersey. I mean, those, those positions were -- you know, let you move up through the chain of command, you know. Those were my experiences there.

My last billet in the Guard was a newly formed -- as the Commander of a newly formed civil support team, an anti-terrorism unit.

And at the time of 9/11, I was training at the National Guard Terrorism Center in San Luis Obispo, California, with other members of my team. And we were ordered to report to the World Trade Center that next day and so forth to assist in the operations there.

Q. Did you receive any awards or commendations during your time with the New Jersey National Guard?

A. The highest award I received was the Meritorious Service Medal. And that was in connection with an exercise that was performed at Fort Leavenworth, Kansas.

Q. Okay. Thank you, Mr. Martens. I want to come back to this matter.

THE COURT: Did you have any active duty before you went in the Guard, Mr. Martens?

THE WITNESS: No, Judge, other than the active

duty once within the Guard, basic training and advanced individual training.

BY MR. MAHADY:

Q. Coming back to this matter, in this matter, Mr. Martens, did you work with a team at PwC?

A. I did, yes.

Q. And can you generally describe the makeup of the team?

A. The team's -- not just -- not that this is unique per se to this job, but all of our jobs are typically staffed in the same manner. There are people like myself with core accounting, core worthy background, and then typically people with technology backgrounds, people that have, that have grown up with, say, degrees in computer science and the like and so forth.

And then there's other various -- to the extent we're involved in different functional -- not so much functional but industry kind of situations and so forth that require additional specialists and we'll bring them on board as well.

Q. Okay. And was there a team that you worked closely with for this matter?

A. Yes. The individual that was -- I worked closely with in terms of -- in charge of really and leading the technology people, his name was Rohan Sen, S-e-n.

Q. And what is Mr. Sen's educational background, if you

know?

A. He has a Bachelor's, a Master's, and a Ph.D. in computer science, computer science field at Washington University of St. Louis.

Q. And at all times, did you actively oversee the work performed by the individuals on the team?

A. All work on this matter was performed under my review and supervision.

Q. Okay.

MR. MAHADY: Your Honor, at this time we tender Theodore Martens as an expert in forensic accounting and data analytics.

THE COURT: Any objection?

MR. FARRELL: Judge, I'd like to preserve my objection until I get a better understanding of which datasets this expert is an expert in. Certainly he's very well qualified.

THE COURT: I guess I should reserve my ruling. You remind me at the appropriate time, Mr. Mahady.

MR. MAHADY: Thank you, Your Honor. If I don't remind you, I'm sure someone on my team will remind me to do so.

THE COURT: Okay.

MR. MAHADY: I am going to move forward, though, with asking him about some of his opinions if that's okay.

BY MR. MAHADY:

Q. Mr. Martens, what opinions are you offering here today?

A. I was asked to, to perform certain analyses of Amerisource's business in Cabell County and the City of Huntington for the period of 2006 through 2014. And I'm here to -- here today to share my opinions with respect to the results of those analyses.

Q. Okay. And have you reached any opinions about the results of these analyses?

A. I have, yes.

Q. And what are those opinions?

A. The opinions are that Amerisource is a full-line, full-line distributor of opioid and non-opioid drug medications in Cabell County and the City of Huntington. The mix of their business is such that they -- that Amerisource sells significantly more non-opioid medications than opioid medications.

And the tracking, the tracking, the growth, if you will, the change in the business seems to track both between those who compare the overall business with that of the changes in the opioid business as well.

Q. Okay. Thank you, Mr. Martens.

I want to now focus on the data that underlies your analysis. Can you describe to the Court what data you

reviewed to form your opinions?

A. The data was largely Amerisource transactional data, but then also too using Dr. McCann's ARCOS data as well.

Q. Okay. And can you describe the transactional data? What is it?

A. The Amerisource transactional data details essentially all of the shipments, the sales that Amerisource made. And, once again, the focus is on Cabell County and the City of Huntington.

And that information details the pharmacy names, their customers, their addresses, their various, you know, each drug that's sold as a different, as a separate line item, the national drug code, the NDC numbers are there, as well as then the quantity shipped, item size, item form, data of that nature.

Q. Okay. Sticking with the geographic scope of your opinions here today, I believe you've testified that it's Cabell County and the City of Huntington; correct?

A. Correct.

Q. Okay. And you're not providing any opinions here today about specific pharmacies within Cabell County or the City of Huntington; correct?

A. That's correct.

Q. Okay. And I believe you also testified that your analysis is confined to the period from 2006 to 2014; right?

A. That's correct.

Q. And why did you pick that time period?

A. That time period jives with the ARCOS time period, the ARCOS data time period of 2006 to 2014.

Q. Okay. And do you understand that was the time period that was the focus of plaintiffs' expert Craig McCann?

A. That's my understanding, yes.

Q. Okay. Did you review the trial testimony of Craig McCann?

A. I did, yes.

Q. Okay. And did you recall Mr. McCann testifying -- Dr. McCann testifying that he determined Amerisource's transactional data to be reliable?

A. I do recall that testimony, yes.

Q. And have you reached the same conclusion in your expert work?

A. Yes.

Q. Okay. I want to focus a little bit more about what's included in your analysis which we will get to.

Your analysis includes all of AmerisourceBergen's customers in Cabell County and the City of Huntington; correct?

A. That's correct.

Q. And, so, that would include independent pharmacies?

A. Yes.

Q. Retail pharmacies?

A. Yes.

Q. And hospitals as well; right?

A. That's correct.

Q. And would that include Cabell-Huntington Hospital and St. Mary's?

A. Yes.

Q. And why did you include all of AmerisourceBergen's customers and not just limit it to pharmacies?

A. To give a, I believe, more complete picture, if you will, a depiction of the full scope and breadth of the business of Amerisource in Cabell County and the City of Huntington.

Q. Okay. And you understand that AmerisourceBergen --

THE COURT: Just a minute.

MR. MAHADY: Sure.

MR. FARRELL: Judge, based on the proffer from this witness, we have no objection to his qualifications for those datasets.

THE COURT: All right. I find Dr. -- I find Mr. Martens to be an expert in the fields of forensic accounting and data analytics.

MR. MAHADY: Thank you, Your Honor.

You threw me off, Paul, in a good way, but we'll get back to it.

BY MR. MAHADY:

Q. All right. The data that you analyzed includes products that were shipped both in solid form and liquid form; correct?

A. That's correct.

Q. All right. And the data that --

A. This is -- by the way, this is the Amerisource data.

Q. Correct. And the AmerisourceBergen data that you analyzed for Cabell County and the City of Huntington also included medications that were both opioid medications and non-opioid medications as well; correct?

A. That's correct.

Q. Okay. And can you explain again why you considered both opioid medications and non-opioid medications?

A. Once again, basically to give the, to give the Court a full and complete picture of the scope and breadth of Amerisource's sales in, in Cabell County and the City of Huntington.

Q. Okay. Mr. Martens, how did you determine looking at the data whether or not an item was an opioid or some other non-opioid medication?

A. With respect to identifying opioid medication, there we utilized the NDC codes from the Amerisource data and then matched and compared them with the NDC codes in the ARCOS data. And when we found a match, that drug was considered

and treated as an opioid drug.

Q. Okay. And since it's been a little while since we've talked about the ARCOS data, just so we're clear, when we're talking about the ARCOS data, we are talking about opioid shipments; correct?

A. That's correct.

Q. Okay.

A. This is the, the data that Dr. McCann had processed and so forth. That's the data we, we compared it to.

Q. Okay. Sticking for a second with the non-opioid medications, were there any types of medications that were more prevalent than others in AmerisourceBergen's data for non-opioid medications?

A. Well, there was -- the ones that come to mind are blood pressure medications, antidepressants, diuretics, different, different drugs dealing with asthma, things of that nature.

Q. Okay. And as far as how you quantify the shipments of those units for both opioids and non-opioids, can you explain to the Court how you did that?

A. We applied a, a consistent approach in the sense that to identify dosage units for the opioids, we multiplied and took the quantity shipped times the item size that was detailed in the, in the data.

And in the case of dealing with the opioid transactions, we were able to check, to check our

calculations there with respect to those dosage units reflected in the ARCOS data and found that our, our calculations were in agreement.

And we applied the same approach when it came to dealing with the liquid, the liquid form of these drugs; taking quantity shipped times the item size and arriving at the dosage units with respect to the liquid form of these drugs as well.

So there was a consistent approach, not only consistent between opioids and non-opioids, but also between liquid form and solid form.

Q. Was AmerisourceBergen's transactional data for Cabell County and the City of Huntington voluminous?

A. Very much so, yes.

Q. Are we talking about a couple hundred transactions or are we talking about tens of thousands of transactions across all products?

A. Probably more on the order of magnitude of tens of thousands of transactions.

Q. Okay. And have you prepared summaries reflecting the substance of the data?

A. The results of the work, yes.

Q. Okay.

MR. MAHADY: Ms. Pierce, if you can please hand the witness AM-WV-02768 and AM-WV-02769.

And, Mr. Serp, if you don't mind pulling up AM-WV-02768.

BY MR. MAHADY:

Q. Mr. Martens, starting with 02768, can you please describe generally for the Court what we're looking at here?

A. What this, with this graph represents is for the period 2006 to 2014 this, this graph is all, all -- the blue line is the total both in liquid form and solid form of the dosage units by transaction year for all opioid and non-opioid transactions in Cabell County and City of Huntington.

Q. Okay. So stopping there for one second, this blue line here that we see trending, this includes all products shipped by AmerisourceBergen into Cabell County and the City of Huntington; correct?

A. That's correct.

Q. Will you describe for the Court what the yellow line is?

A. The yellow, the yellow line is a subset of that data. And the yellow line reflects the transactions involving the ARCOS 14 drugs.

Q. Okay. And for purposes of this analysis, does this include both opioids and non-opioids in solid form and liquid form?

A. It's both. It's both solid and liquid, yes.

Q. Okay. And did you make any observations when you looked at this chart?

A. I think the observation that, that one can make is in terms of the trends. As you start to see the overall business growing for the period in those early years, you see sort of -- you see a similar trend with regards to the growth in the ARCOS 14 drug line as well.

The one thing that you find is happening here, though, is that the non-opioid growth appears to be outpacing the opioid growth during that time frame.

Q. Okay. And just so we're clear here, if I understand you correctly, what you're saying is looking at the blue line, this blue line, non-opioid growth is outpacing the growth of the opioid products; is that correct?

A. That's correct.

Q. Okay. And based off of your analysis, did both the all prescription drugs and the opioid distribution drugs peak in or around the same time?

A. They appear to have peaked in the same time frame there, that being the year 2009.

Q. Okay. So we're looking up here to the blue line and down here for the yellow line?

A. That's correct.

Q. Okay. Mr. Martens, can we move to the next chart that

you prepared? I believe that number is 2769.

A. 2769.

MR. MAHADY: Mr. Serp, can you pull that up?

BY MR. MAHADY:

Q. Okay. And, Mr. Martens, can you generally describe for the Court what this chart shows?

A. What this chart shows is, once again, this is for all products, all medications for the period 2006 through 2014, Cabell County and the City of Huntington, essentially the business mix.

You have in the, in the blue bars there on the chart the percentage of non-opioid transactions, and then with the orange the percentage of opioid transactions for each of the years.

Q. Okay. So if we just start in 2006, just so I understand this correctly, to make sure I understand it correctly, the entire bar reflects the totality of AmerisourceBergen's distribution into Cabell County and the City of Huntington for 2006; correct?

A. The entire bar, that's correct, yes.

Q. Okay. And this includes both liquid and solid form drugs; correct?

A. For this, for this chart, that's correct, yes.

Q. Okay. And am I correct that 5.76 percent of AmerisourceBergen's distribution for that year, 2006,

reflected opioid medications?

A. That's correct.

Q. And 94.24 percent reflected non-opioid medications?

A. That is correct.

Q. Okay. And I know this is somewhat annoying, but can you just go through from 2006 to 2014 and just read the percentage of opioids and the percentage of non-opioid medication for each year just for the record?

MR. FARRELL: Judge, I'm sorry. If it saves any time, the plaintiffs would stipulate and allow for the admission of the document if he doesn't want to read it all in.

MR. MAHADY: That does save some time. We were going to move at the end for the admission of these under Federal Rule of Evidence 1006. We can do that now.

THE COURT: Is there any objection to the admission into evidence of these documents?

MR. FARRELL: No, Your Honor.

THE COURT: Okay. They are both admitted. 02769 and 02768 are admitted.

MR. MAHADY: Thank you, Your Honor.

BY MR. MAHADY:

Q. So, Mr. Martens, I'm not going to have you read the numbers now. But did you make any observations off of your analysis reflected in this chart?

A. I think what the chart reflects is, is that the sale of the non-opioid medications was significantly greater than the opioid medication transactions for all of the years within the time period.

Q. Okay. And just circling back on one point, the two charts we looked at, those included medications that were shipped in liquid form; correct?

A. These, these two drugs are both liquid and solid.

Q. Okay. And that would include medications that were shipped to the hospitals and pharmacies in liquid form; correct?

A. That's correct.

Q. Okay. Did you also prepare two charts that just focused solely on medications shipped in solid form?

A. I did, yes.

Q. Okay.

MR. MAHADY: Ms. Pierce, can you hand those to Mr. Martens, please?

Mr. Serp, if you can please pull up AM-WV-02770.

BY MR. MAHADY:

Q. Okay. Mr. Martens, can you please describe generally what this chart reflecting your analysis and summary contains?

A. This chart reflects the similar analysis as to what I just described with respect to the, the first two charts.

This chart, however, is focused solely on solids only; in other words, taking from the item form of the transactional data solids, pills, caplets, capsules and identifying the total dosage units by year, 2006 through 2014 for transactions in Cabell County and the City of Huntington. That's the blue line at the top, and then a subset of that data in the orange line below for the ARCOS 14 drug data.

Q. Okay. So just so I'm clear, the blue line reflects all solid form medications that AmerisourceBergen distributed into Cabell County and the City of Huntington for the 2006 to 2014 time period; correct?

A. Solids only, correct, yes.

Q. Okay. And the orange line down here reflects the opioid solid form that AmerisourceBergen shipped into Cabell County and the City of Huntington for that time period as well; correct?

A. That's correct.

Q. Okay. Could we please move to the next chart which is, for the record, AM-WV-02771.

And, Mr. Martens, can you describe what this chart shows?

A. This is now a bar chart reflecting the percentages of non-opioid versus opioid sales transactions, solids only, into -- you know, distributed to Cabell County and City of

Huntington for the period 2006 to 2014.

Q. Okay. So even if we were to strip out AmerisourceBergen's distribution of liquid products to its customers in Cabell County and City of Huntington, only 84.31 -- or only 15.69 percent of the pill forms were for opioid products; correct?

A. That's correct, right.

Q. And 84.31 percent of the pill form products that it shipped into Cabell County and the City of Huntington were for something other than opioid products; correct?

A. That's correct. Those are non-opioid medications.

Q. Okay. And is that generally consistent across the time period from 2006 to 2014?

A. Generally consistent. I think you'll find that there's -- the distribution -- appears to be generally consistent, yes. There's a few percentage points here and there. But by and large, you can see that there's a, still a significant amount of non-opioid medications being transacted, distributed when compared to the opioid transactions.

Q. Okay. Let's see if we can spare the witness and the Court from reading the numbers.

MR. MAHADY: Your Honor, at this time we will move AM-WV-02770 and AM-WV-02771 into evidence under Federal Rule of Evidence 1006.

THE COURT: Any objections?

MR. FARRELL: No objection, Your Honor.

THE COURT: They're both admitted.

MR. MAHADY: Thank you, Your Honor.

BY MR. MAHADY:

Q. Mr. Martens, do you offer all of the opinions here today with a reasonable degree of professional certainty?

A. I do.

MR. MAHADY: At this time, I have no further questions. Thank you, Mr. Martens.

THE COURT: Okay. You may cross-examine.

CROSS EXAMINATION

BY MR. FARRELL:

Q. Good morning, Doctor. My name is Paul Farrell. We haven't had a chance to meet yet.

A. Good morning. I'm not a doctor.

Q. Oh, I'm sorry. You have the pedigree of one with your background and experience.

A. Well, thank you.

Q. I just had a couple of questions for you.

You testified that you reviewed Dr. McCann's processed ARCOS data as part of your analysis; correct?

A. That's correct.

Q. And you said that you also reviewed the

AmerisourceBergen transactional data?

A. That's correct.

Q. And just to be clear that you're aware that AmerisourceBergen's transactional data is broader in time than the ARCOS data?

A. I understand that there's broader data available, yes.

Q. And I believe you just testified that the AmerisourceBergen data you found to be reliable. My question is did you also find the McCann processed data to be reliable as well?

A. I did, yes.

Q. No faults with Dr. McCann's math?

A. With respect to Dr. McCann's math on --

Q. The processed data.

A. The processed data, yes.

Q. No faults?

A. I don't know if I could go so far as to say no faults, sir, but I found it to be reliable.

Q. Thank you.

MR. FARRELL: Can we bring up 2768 that was just admitted?

BY MR. FARRELL:

Q. Exhibit 2768, the bottom line here is the opioids sold by AmerisourceBergen into Huntington, Cabell County between 2006 and 2014; correct?

A. That's correct.

Q. And this is just the -- this framing of time is just because that's what the overlap is between ARCOS and AmerisourceBergen's transactional data?

A. That's how, that's how the analysis was performed and that's how this chart reflects the results of the analysis to match with the ARCOS time frame.

Q. Now, if you were to add up all of these numbers on the bottom line, it comes to -- and I won't ask you to do the math -- 49 million dosage units.

My question, sir, is have you undertaken any analysis as to whether 49 million dosage units have any economic impact upon Huntington/Cabell County, West Virginia?

A. I have not performed such an analysis, no, sir.

Q. Did you make some analysis as to whether during this time frame 49 million pills were appropriate for the size population?

A. I have not performed such an analysis, no, sir.

Q. And did you take the orange line here that goes over time and compare it to other orange lines for other counties in West Virginia?

A. I have not performed that task, no, sir.

Q. Or any other county in the United States?

A. I have not performed that, no, sir.

Q. But could you have, based upon the data provided by

AmerisourceBergen, compared the volume of pills in Huntington/Cabell County to other places around the country?

A. Well, to the extent I had the data, I could re-perform, I could re-perform that analysis, yes, sir, not just, not just around the country but for the State of West Virginia if that's your question.

Q. Okay. And what about pricing? Were you able to determine the -- how much revenue was generated from the sale of these pills?

A. I did not, I did not do that calculation, no, sir.

Q. But could you have?

A. I'm not sure. I'd have to, I'd have to check to see if the information is available. I would assume that these transactions are driven over the sales and the sales ledgers at the company and then identify what the, what was for each item and so forth in the charts and so forth pulling that off the transactional data.

Q. And when were you hired in this case, sir?

A. It's hard -- I started working on the State of West Virginia information I want to say probably in the summer of 2020.

Q. Thank you. No further questions.

THE COURT: Any redirect, Mr. Mahady?

MR. MAHADY: No redirect, Your Honor. Thank you.

THE COURT: May the witness be excused?

MR. FARRELL: Yes, Your Honor.

THE COURT: Colonel Martens, thank you, sir, very much. You're free to go.

THE WITNESS: Thank you, Judge.

MR. HESTER: Your Honor, the defense calls our next witness, Dr. Kevin Murphy.

THE COURT: All right.

MR. HESTER: Is it convenient for the Court to take a break now or would you prefer that we get started? I'm happy to do it either way, Your Honor.

THE COURT: Well, let's go ahead and take 10 now.

(Recess taken at 10:03 a.m.)

THE COURT: All right. Mr. Hester?

MR. HESTER: Your Honor, the defense calls Dr. Kevin Murphy to the stand as our next witness.

COURTROOM DEPUTY CLERK: Please state your name.

THE WITNESS: Kevin M. Murphy.

COURTROOM DEPUTY CLERK: Thank you. Please raise your right hand.

DR. KEVIN M. MURPHY, DEFENSE WITNESS, SWORN

COURTROOM DEPUTY CLERK: Thank you. Please take a seat.

THE COURT: Good morning, sir.

THE WITNESS: Good morning, Your Honor.

DIRECT EXAMINATION

BY MR. HESTER:

Q. Good morning, Dr. Murphy. Could you please introduce yourself to the Court?

A. Yes. My name is Kevin M. Murphy. I'm a George J. Stigler Distinguished Service Professor of Economics in the Graduate School of Business in the Department of Economics at the University of Chicago.

Q. And, Dr. Murphy, when did you complete your education?

A. I got my BA, I believe, in 1981 from UCLA, University of Southern -- University of California at Los Angeles, and I got my Ph.D. degree from the University of Chicago in 1986.

Q. And how long have you been an economics professor at University of Chicago?

A. I started teaching at University of Chicago, I believe, in 1983 while I -- before I finished my Ph.D. degree, I started teaching at the university and I've been there since then teaching. From '83 until today, I teach at the university.

Q. And what departments do you teach in at the university?

A. I teach in both Booth School of Business and the Department of Economics.

Q. So, Dr. Murphy, could you give the Court a sense as to the reputation of the University of Chicago in the field of economics?

A. It has a pretty good reputation in economics. It's produced probably the most number of Nobel Prize winners, I think, out there. People like Milton Friedman and George Stigler, very famous economists taught there. Gary Becker was one of my mentors out there.

THE COURT: I'm well familiar with the reputation of the University of Chicago.

MR. HESTER: It was a little bit of a softball for Dr. Murphy.

BY MR. HESTER:

Q. What courses do you teach at the University of Chicago?

A. I teach microeconomics, which is the study of markets and how markets work. I also teach labor economics. I also teach public policy. I also teach a course in sports analytics. But the core of my teaching is really in the microeconomics area and I'm very fortunate to be able to teach in both Booth and the Department of Economics Ph.D. program in that.

Q. And, Dr. Murphy, when you refer to microeconomics, maybe you could expand on that a little bit more. What's the focus of microeconomics?

A. In economics, we make two broad distinctions between macroeconomics, which is the people who talk about GEP and the growth of the economy as a whole and things like that. I like to think of that as the voodoo side of economics.

Then we do the microeconomics, which is kind of what I do, which is really the study of markets and how markets work. And that's what I do in my research and that's what I do in my teaching. It gives you some insights at the macro level, but it's much more focused on individual markets and how they operate.

Q. And so, is it fair to say that the focus of your work is on the behavior of firms and the behavior of particular markets?

A. Yeah. I would say to understand a market, you usually have to think about both the supply and the demand side. Where you think about the customers and the ultimate users of a product on one side and the providers of the product on the other side, including the supply chain component of that. That's a part of economics we cover a lot in micro called drive demand, where we study demand for various components or parts of the products that are ultimately sold.

Q. And beyond your role in teaching, Dr. Murphy, do you publish academic research in the field of economics?

A. I do. I've published a number of papers in a pretty wide area of economics.

Q. Do you have a sense roughly as to how many papers you've authored or co-authored?

A. About 80, I think I've published on, either authored or

co-authored over my career.

Q. And have those articles been published in a number of the leading scholarly and professional journals?

A. Yes, they have. I've published in Journal of Political Economy, American Economic Review, Quarterly Journal of Economics. Those are probably the top journals in economics.

Q. And have some of the articles that you've written been widely cited in the field?

A. They have. I have a number of works in different areas that have been pretty widely cited.

Q. Are there a few you could just give us as illustrations?

A. Yeah. I did -- I did some of the early work on growth and income and equality and changes in the patterns of unemployment and education. I've done work on health economics and the value of improvements in health and longevity that's been widely cited in the health economics area.

I've done work on the markets for illegal drugs, addiction. Those would probably be the areas that are cited most. Similarly, my work on economic growth also is pretty highly cited.

Q. Have you also published some books on economics?

A. I have. I've published books on social economics, on

price theory, which is really throughout my microeconomics courses that I teach and particularly my Ph.D. class. Also, edited books on healthcare and markets and value of health and longevity.

Q. Dr. Murphy, have you received any awards during the course of your career in economics?

A. I have. I received the John Bates Clark medal, which is -- at the time was awarded every other year to the outstanding American economist under 40. As you can guess, that was awhile back. I'm no longer under 40.

I also received a MacArthur from the MacArthur Foundation and I was awarded the Kenneth J. Arrow prize for the outstanding paper in health economics. So, yeah, I have a number of awards.

Q. Other than your work at the University of Chicago, are you also affiliated with any other organizations?

A. I am. I -- I'm affiliated with Charles River Associates where I am a senior consultant.

Q. Are you also a member of some academic academies?

A. Yes. I'm a member of the American Academy of Arts and Sciences, a member of the Society of Labor Economists. I don't remember all of the other ones.

Q. Are you also affiliated with the Econometric Society?

A. Yes. I'm a fellow of the Econometric Society. Sorry. I forgot about that one.

Q. And do you also have a role with the National Bureau of Economic Research?

A. I do. I'm a -- I don't remember the title, but I've been with the NBER, the National Bureau of Economic Research, for -- since the 80s. So, you know, almost 40 years now.

Q. Dr. Murphy, you mentioned you serve as a senior consultant to Charles River Associates. Can you describe what Charles River Associates is?

A. Yes. It's a consulting firm and, certainly, the part I'm involved is an economic consulting operation where we consult on a wide range of matters, including litigation matters like this.

Q. And are there some particular kinds of matters that you focused on in your consulting work for Charles River?

A. I've done a fair number of different things. Antitrust. I do a lot of work in antitrust. I've done work on patent damages. I've done work on labor cases. I've done work on health -- you know, healthcare-related things. I've done a number of things.

Q. So, during your time at Charles River Associates or in relation to that affiliation that you have, have you worked on problems related to the pharmaceutical industry?

A. I have. I've worked on a number of pharmaceutical matters.

Q. Have you previously served as an expert witness in litigation?

A. Yes, I have.

Q. And how many times roughly have you served as an expert witness?

A. You know, it's hard to know. I can't remember. Testifying in trial, probably between 10 and 20 would be the number of times I've testified at trial. I've given more deposition testimonies than that, clearly, because a lot of things don't go to trial.

Q. And have a number of your expert engagements involved matters related to health economics or the pharmaceutical industry?

A. They have.

Q. Have you previously been qualified as an expert in the field of economics?

A. Yes, I have.

Q. Have you previously submitted expert testimony to the United States Congress?

A. Yes, I have.

Q. Could you describe that briefly?

A. Yeah. I just -- I have testified before the U. S. Senate on minimum wages, would be the one that I remember.

Q. And have you previously submitted expert testimony, as well, to state regulatory bodies?

A. I have.

Q. Could you describe that just briefly?

A. Yeah. I've submitted testimony in Illinois, before state regulatory bodies in Illinois.

Q. In the course of your expert engagements, are you always representing private companies or have you also worked for other kinds of entities?

A. I've worked for the federal government. I've consulted for both Department of Justice and the Federal Trade Commission.

MR. HESTER: Your Honor, at this time, we would tender Dr. Murphy as an expert in the field of economics with a specialty in health economics.

THE COURT: Any objection?

MR. FARRELL: Again, reserving the right, depending on the subject matter that he's being proffered for here, but he's certainly an expert in both those general fields.

THE COURT: Well, I find him to obviously be an expert in the fields of economics and especially health economics.

BY MR. HESTER:

Q. So, Dr. Murphy, in your career as a professional economist, have you developed an expertise in market forces and supply chain? I think that's probably a pretty easy one

for you.

A. Yeah. I think I answered that already. And, yes, that's part of -- a big part of what we do in microeconomics.

Q. And does any of that expertise relate specifically to economics of healthcare markets?

A. It does. I've done work on healthcare markets, you know, related to both innovation, as well as payment structures, things like that, about how those -- the forces that work in healthcare markets.

Q. And in connection with your work on this matter, have you reviewed materials related to the Closed System of Distribution for controlled substances like prescription opioids?

A. I have. Again, I am not an expert from the point of view of all the legal aspects and the regulatory aspects. I am an economist. So, my understanding is the economics of that industry and how that industry works from an economics perspective.

Q. And based on your experience and your review of these materials, have you been able to develop an understanding as to the role from an economics perspective that distributors play in that system of distribution of controlled substances?

A. I have.

Q. And what's the -- what's the understanding you've been able to develop?

A. Well, I think the way to think about it is distributors' role is that they -- they purchase pharmaceuticals from manufacturers and distribute them and sell them to the pharmacies or other distribution outlets downstream and, therefore, the amount that they distribute is -- for example, of a controlled substance like opioids would be determined by the prescribing behavior because it's the prescribing behavior that determines the amount that pharmacies are going to need to fill those prescriptions and that then in turn determines how many prescription opioids are going to be shipped.

Q. So now, there's been testimony in this case about an alleged oversupply of prescription opioids in Cabell County and the City of Huntington. Have you had a chance to review some of that testimony?

A. I have. And let me kind of tell you how an economist would think about that. In economics we make a distinction between three things that are related but different.

One is what we might call quantity, or consumption, or level of output, depending on whether you're looking at it from the consumer's point of view, or the producer's point of view, or just the market point of view. That's the outcome. That's how many units were sold in the

marketplace.

We think of a separate thing called supply, which is on the -- forces that work on the supplier side of the market and demand and the quantity you see is a function of both the supply and demand.

It's not a measure of supply per se. It's a measure of the quantity which is a function of both. So you want to keep that in your mind when you talk about like the level of output or the level of consumption. It really is an outcome.

And, for example, you can't say, well, geez, we had more output and, therefore, there was an increase in supply. Economists wouldn't think about it that way.

You know, people consume more gasoline. It could be because we discover a lot of oil and oil prices go down and people buy more gasoline because it's cheaper, but it also could be a bunch of people move to the suburbs and they get richer and they demand more gasoline and the quantity of gasoline goes up for demand forces. And just the fact that the quantity went up doesn't tell you it was something going on on the supply side.

Q. And so, in relation in particular to the distribution of prescription opioids and the sale of prescription opioids, is there a particular driver of demand that you've identified?

A. Yeah. As I said a bit ago, I think prescriptions -- if you wanted to think about market like this and what's going to determine the quantity, it's going to be the prescribing behavior.

Q. And why is that?

A. Well, because in order to sell a prescription, legitimate prescription, or a legal prescription in this marketplace, you have to have a prescription.

This is not like you go down to the grocery store and say, you know, oh, I see there's a stack of doughnuts. I'll buy some doughnuts. That's not how this works.

You need a prescription to buy it and my understanding of the evidence in this case is that the opioids that were distributed were distributed overwhelmingly for -- through prescriptions. So, it's prescriptions would be the driver.

Q. And you had mentioned before, Dr. Murphy, that the responsibility for prescriptions lies where?

A. Well, if you think about who influences the prescriptions primarily, at the point of the spear, kind of like where that actually happens, it's going to be the doctors and the patients, right?

Ultimately, the doctor is going to decide to write a prescription and the patient plays a role in that and, you know, then there's a question of whether patient fills that or not. That's also a patient level. So, it's doctor and

patient that probably play the greatest roles. All the other things that might influence doctors and patients but, ultimately, it's going to work through them.

Q. So, given these factors that you're discussing in this industry, do distributors determine the quantity of prescription opioids that are sold in a community?

A. Well, they -- not directly because they don't really -- they don't really have levers at the level of prescription, that if you think about a distributor's decision, they're not deciding about whether to supply opioids for a particular prescription and they're not deciding whether those opioids dispensed through that prescription are going to be used by legitimate use or diverted in some other way once they're outside the pharmacy, right? They don't -- they don't act at that level. They act at a more aggregate level where they're making decisions on -- you know, on -- their distributing the product to the pharmacy, but not affecting the prescriptions directly.

Q. And when a pharmacy places orders with a distributor, what's your understanding as to what the pharmacy is doing? How does the pharmacy decide on how much it chooses to order from a distributor?

A. Again, I'm going to give you economics, right? The pharmacies are a profit maximizing business. They're out there looking for their -- to run their business. They're

going to distribute opioids, it's my understanding, pursuant to prescriptions.

So, when they order, they're going to order based on what they expect to get in terms of prescription volume. It doesn't -- it's not in their interest to have opioids just piling up in the pharmacy if there's not prescriptions to be filled. So, they're going to base their orders on some anticipated notion of prescriptions. That's what economics tells us.

Q. So, is an association between the quantity of opioids sold in a community and the -- and opioid mortality significant or meaningful from an economic perspective?

A. Well, I think it depends on the question you're asking. If you're asking does that tell me something about, say, distributor behavior, probably not. Not very helpful in that regard.

The idea that when there are more opioids being consumed there might be more things like overdoses, that kind of in an extreme sense has to be true, right, because if you didn't consume any opioids, you couldn't overdose on prescription opioids.

So, it doesn't really tell you about why. It doesn't tell you what happened. It just tells you kind of the outcome, not -- not the genesis of that outcome.

Q. So, there's an association between the quantity of

opioids sold in the community and opioid mortality established that distributors' conduct caused that increased mortality?

MR. FARRELL: Judge, before we move forward, I just wanted to make sure that the testimony that was being elicited is from an economic standpoint and an economic analysis only. That question was broad enough that it invokes other disciplines perhaps, such as epidemiology, but to the extent that the question is parked or framed in terms of economics, we have no objection.

THE COURT: Well, I'll overrule it. Well, you don't have an objection.

You can answer the question, Dr. Murphy, if you remember what it was.

THE WITNESS: Can I get it repeated?

BY MR. HESTER:

Q. Sure, sure, sure.

A. That would help me. Sorry about that.

Q. Dr. Murphy, does an association between quantity of opioids sold in the community and opioid mortality establish that distributors' conduct caused that increased mortality?

A. No. I mean, again, if you study the economics, there's -- you know, that would -- that association would exist even if distributors did nothing to cause that.

Q. So, maybe just talk a little bit more broadly from the

perspective of economics, Dr. Murphy, about the relationship between these terms association and causation. Talk a little bit about that.

A. Well, they're different because association, it's really more of a statistical concept but, you know, part of economics is we do a lot of statistical work and, certainly, that's a big part of my career, is applying economics to data.

Association just tells you things move together. There's a tendency for A to go up when B goes up.

So, for example, you would see an association between rain and the use of umbrellas, right? There's a pretty strong association. People tend to use umbrellas when it's raining, but you wouldn't infer that umbrellas cause it to rain.

You know, I might have a drought. I can't run outside with my umbrella and put it up and get rain to come down. You know, that would be a misinterpretation and that would be an example of distinction between -- in that case, it's sort of simple because causality runs the other way.

Sometimes, things are associated where there's no causality either way. They just are both caused by the same forces. So, there's a big difference between association and causation.

Q. So, when we use this phrase association, does it

signify that two things are observed happening together or sequentially? Is that what it means?

A. Association could be different types of association. There's what we would call a time series association, which means over time they happen together. There could be a cross-sectional association, the same locations where A happens, B also happens; or when A doesn't happen, B doesn't happen, right? Those would be both notions of association, one over the time dimension and one over the cross-sectional dimension.

Q. So, Dr. Murphy, have you analyzed the relationship between the shipments of prescription opioids and opioid-related mortality?

A. I have.

Q. And have you prepared a demonstrative as part of your expert report in this matter that would assist in explaining your analysis?

A. Yes, I have.

MR. HESTER: So, let's see if we can put that up on the board.

BY MR. HESTER:

Q. So, Dr. Murphy, we've put up on the board here an exhibit from your expert report. Can you describe what's depicted on this chart?

A. Yeah. This has got two lines on it, so this is what we

call a line chart. The years are on the horizontal axis and what we're measuring is on the vertical axis. So, those lines tell you at each year point for that year what was the level of the indicated variable.

So, the left hand axis is MMEs per adults in West Virginia. That's the blue line. And it shows you how it behaves.

So, basically, MME per adult was going up from the beginning of the dataset here and peaks right around 2011-2012, after which it has a pretty precipitous decline.

So, actually, if you look at this outcome we call quantity or shipments it's right at the outcome. It's not a measure of supply. It's just a measure of outcome. That was what shipments did over this period of time.

So, they first rose and then declined in the last, you know, seven years, six years or seven years of the data.

Q. And let me just pause you there again just to make sure we've got it clear between this point you made about supply and quantity. The blue line, which shows a rise between 1995-96 and 2010-11 and then a decline going out to 2017, that's reflecting a quantity in the marketplace; is that fair to say?

A. Yes. I mean, you could think about it as it's quantities of shipments. It's the number of opioids shipped. It's quantity measure. It's a measure of the

outcome in the market, which is a function of both supply and demand.

Q. And as a matter of economics you would view that quantity as the outcome of decision making by doctors?

A. I think if you -- yeah. Ultimately, in this case, it would be determined by the decision making of doctors and patients, right, because doctors work to get -- you know, the prescription is something that's done between the doctor and the patient because, hopefully, doctors take some input from the patients and my understanding is that they do. So, it would be the both of them and that's not to say that there are other things that come in.

For example, I saw somebody earlier today talked about payers. Payers have some influence on those prescriptions because they determine the terms under which, for example, reimbursement is going to happen, which is going to influence prescribing behavior. So, they're kind of inside that -- that -- that decision making process.

Q. So, let's look at the underline here, the black line. Could you describe what that is, Dr. Murphy?

A. That's mortality rate measured as deaths per 100,000 people. So, it's the opioid mortality rate, including both licit and illicit opioids. I think people talked about that already, so I'm not introducing anything new there, but it's all types of opioid mortality over that time period.

And what you see here is it's not a really simple association, right? We're not talking causation at this point. We're talking about just simple association. The association here isn't one where one goes up the other one always goes up. We had two very distinct periods. They were both going up. So, that's called -- up through 2010 or so, maybe it's '11, you know, right around in that time period.

And then they -- you know, if anything, mortality accelerates and shipments go down. So, you have to kind of understand. You know, if you want to understand what's going on, you really want to understand both those periods. How do I -- how do I think about the marketplace from an economics standpoint what's going on in those two periods.

Q. So, just to be clear, the opioid mortality line here includes both illicit and prescription opioids, correct?

A. It does. That's what I said. The mortality -- all opioid mortality -- the shipment data are only -- obviously, because they'll come from ARCOS, they're going to be prescription opioids.

Q. And could you expand a little bit on your point that it's not a simple association?

A. Yeah. We talked earlier about association, right? We talked about it as one thing goes up, the other one goes up or one goes up and the other goes down. Those would be

called positive and negative associations.

The associations here look really different in these two time periods. We had this first period where they were both going up; and then, we had the second period where one -- the shipments are going down but, if anything, the mortality is going up faster, not slower.

Q. And so, what does that tell you about the need to evaluate this association? Where do you go from here as you're evaluating this?

A. Well, I think you need to try to understand those two periods. You need to understand what was going on in that earlier period. And then, you particularly need to understand that later period and you need to understand well, geez, why is mortality going up in this later period while prescription opioid shipments are actually going down? So, it's getting behind these figures, I think, that's important.

Q. So, let's talk first about that pre-2010 period, Dr. Murphy. During that pre-2010 period, again, what do you see happening with prescription opioid shipments and opioid mortality?

A. They're both going up and, again, that's telling me that people -- there were more pills being consumed or presumably. It would certainly be more shipped and more prescriptions being written. So, we had more and more

prescriptions for opioids over this period and over that period mortality was going up.

It doesn't tell us a causal story in a sense of was it supply, was it demand. There probably is some link between quantity of one and the other because, as I said earlier, you can't overdose if you don't take it in the first place.

But that doesn't establish, for example, something like a causal relationship back to distributors, again, because it's coming through prescriptions, presumably, it's working through prescriptions. And, as I said earlier, distributors aren't really the primary or even significant determinant of those prescriptions being written.

Q. So then, let's look at the post-2010 period. At that time, after 2010, what's happening between prescription opioid shipments and opioid mortality?

A. Well, we'll get behind that in a minute, but what's happening at the gross level, obviously, as I said earlier, is that prescription -- shipments of prescription opioids are going down, but mortality is going up and, indeed, going up more rapidly, if anything, than it was before.

Q. And so, what was driving the increase in opioid mortality in this period after 2010?

A. It was an expansion, if you -- well, we'll see this in a moment. It's an expansion in the use of heroin and, in particular, the growth of fentanyl as a much more lethal

form of illicit opioid.

Q. And have you had occasion to analyze this point about the relative impact of illegal opioids like fentanyl and heroin on opioid mortalities? Is that something that you've looked at for the process?

A. I have.

Q. And what are the results you've reached at the highest level? We'll drill into it in more detail, but what are the -- what's the highest level conclusion you've reached?

A. I would say it was what I said just a moment ago, that it's really the growth and mortality in that later period that's really driven by a growth in, first, heroin mortality; and then, later, a substantial growth in fentanyl-related mortality.

Q. So, let's go on to the next exhibit where we can drill into this a little bit more. So, we've put up Exhibit 33, Dr. Murphy. Is this another exhibit from your report?

A. It is. It was Exhibit number 33 in my report. That's where the 33 came from because it's not 33 for today. We're sparing you a lot of the other ones.

Q. What does this chart reflect?

A. It looks at adult deaths per 100,000. So, that's a mortality rate. And it breaks it out between prescription opioids, which is the black line, and heroin and fentanyl together, which is the blue line.

So, I'm not separating heroin and fentanyl right now. I'm putting those together. So, we'll call those the illicit opioids, heroin and fentanyl, although some of the fentanyl is actually prescription. So, it's not quite all illicit even though, in the later period, most of it is going to be illicit, but --

Q. So, just for the record, could you describe the shape of the -- of the black line, the prescription opioid line?

A. Yeah. The prescription opioid line is rising up through that same 2011 or so period, after which it declines.

Now, I should say one thing. Sometimes and it's not -- you know, we have people when they die who have both heroin or fentanyl and prescription opioids. In this figure, I've put that mixed group into the heroin and fentanyl category. That's the more lethal category.

Q. Why did you do that?

A. It seemed -- if you were going to put them one place or the other, it seemed like a better place because those are the more lethal drugs. So, it seemed to make more sense to put them there.

I've also re-done this chart done the other way. It'll make the heroin and fentanyl line go up a little less because you're taking people out of that one and the decline in the prescription one is a little -- is less. So, it

won't change qualitatively the story. I just wanted to make sure that was clear how I had done it.

Q. So, this is showing opioid mortality rates. So -- so, what does it show about the prescription opioid mortality rates?

A. Well, it says that they were going up until about 2011. And then, since 2011, they've been going down.

Q. And what does it show about the illicit drug mortality rate, heroin and illicit fentanyl?

A. Well, be careful. Remember, heroin is illicit, but fentanyl, there's some of both, right? And chemically you can't tell whether it was prescription fentanyl or -- or illicit fentanyl. So, they're combined together in this blue line, but that huge increase in that later period, I will give you -- show you how you know that in the later period is mostly the illicit fentanyl driving that.

Q. Yeah. I was going to ask you that. Your understanding is most of the spike period here we're seeing after 2011 or so reflects illicit fentanyl?

A. Yeah. I think that's generally accepted. I think Dr. Keyes, you know, found the same thing. I don't -- I don't know of anybody who would disagree with that as the big story for that later period.

Q. So now, let's go to the next exhibit. Dr. Murphy, we've put up another chart on adult opioid mortality rates.

What does this chart show?

A. Again, this is -- now this is taking that -- remember in that previous graph, 33, I had heroin and fentanyl together? Here, I'm breaking them out separately. And so, I've got the green line being the heroin and fentanyl being the blue line.

Now, again, we're going to have this overlap issue. So, I've put in the fentanyl category anything that has fentanyl. So, if it's fentanyl and heroin, it goes in the blue line. If it's only heroin, it goes in the green line.

Q. And just for the record, could you describe what the heroin line -- what the shape of the heroin line is?

A. Yeah. The heroin really begins increasing pretty significantly. It had been creeping up earlier, but it really begins increasing around 2010. It peaks in 2015, after which it declines somewhat. Fentanyl is pretty flat between 2010 and 2013, but then skyrockets starting around 2013.

THE COURT: Mr. Farrell?

MR. FARRELL: I would simply ask for a geographic scope to be proffered for the record, Your Honor.

BY MR. HESTER:

Q. What is the geographic scope of this chart, Dr. Murphy?

A. Thank you very much for clarifying. This is the U. S. as a whole. So, this is the U. S. chart. This is opioid

mortality for the U. S. as a whole and what we just talked about, all those timing issues, pertain specifically to the U. S. as a whole.

Q. That's a nice segue to the next question I had on my outline. Do these patterns also hold true in West Virginia, Dr. Murphy?

A. Yeah. I mean, at a general level, you see a similar timing story for West Virginia. All of the magnitudes are different. Now, that's an important thing to keep in mind.

Q. So, let's go to Exhibit 35.

A. Right.

Q. So, Dr. Murphy, what do these charts show?

A. Well, these charts do -- remember, we had just looked at 33 and 34, which were the U. S. as a whole. 33 was prescription in the black line and heroin and fentanyl in the blue line. We've just re-done that here in the same methodology for West Virginia.

And, again, what you see is that the prescription mortality is rising up until about 2011 and declines after 2011 and the heroin and fentanyl mortality again starts going up. Again, it was rising, but it starts rising much more rapidly after, you know, 2012 or so.

Q. And then, what does Exhibit 36 show?

A. Exhibit 36 shows kind of a similar pattern to what we saw before, which is, you know, heroin first rising after

2010, rising up peaking, in this case, around 2013 and then going down and fentanyl really taking off after 2013.

Two things to note here. Again, I've done the divisions of the overlaps the same way I did before. So, the overlap story is the same.

But also, the scales here. That scale, I think, on the other chart went to 14. The scale here goes to 50. So, even though they look similar in terms of shapes, it's a much bigger magnitude in West Virginia. So, what happened in the U. S. happened to a greater extent in West Virginia.

Q. And when you say a greater extent, what do you mean by that, Dr. Murphy?

A. Just the magnitude. Just, you know, so we're at a peak here. At a heroin and fentanyl death rate above 40, we're going to peak for the U. S. as a whole at a much smaller number than that.

Q. So, as we look at these West Virginia charts, what does this tell you about the present day opioid mortality in West Virginia?

A. It's overwhelmingly driven by heroin and fentanyl and, in particular, fentanyl. Fentanyl is where the action is in terms of morality today.

Q. And when you're referring to fentanyl, are you referring to illicit fentanyl?

A. It's -- and we'll see some evidence more from this

later. You know, not all fentanyl is going to illicit. There is -- there is prescription fentanyl, but the big increase is from illicit fentanyl.

Q. Dr. Murphy, have you performed an analysis as to whether increased prescription opioid shipments prior to 2010 drove the increase in illicit opioid mortality after 2010? Is that a question you've looked at?

A. I have. I've done some economic analyses to try to get at that question.

Q. And maybe we could just pause again for a second. What's the reason to look back at shipments before 2010 of prescription opioids to evaluate the impact on opioid mortality after 2010? What's the reason to do that?

A. Well, there are two reasons. One is, obviously, the story in the late-year period is illicit mortality, particularly in mortality associated with fentanyl. The greatest level of shipments were occurring in that earlier period and, in my understanding of what I've read in Dr. Keyes and others of the plaintiffs' theories, is that really what we see in that later period was driven by the prescribing behavior that happened in the earlier period. And so, it was the earlier prescription opioid, you know, decisions or the outcomes that drove the later period. And I tried to evaluate that from an economic standpoint.

Q. And what is the opinion you've reached at a high level?

A. I would say the theory -- the economic evidence doesn't really fit that theory very well. I think that the evidence that I've seen really seems to say, you know, there's a lot of things going on after 2010-11 that really aren't that well associated or, you know, don't fit with the story that it was the result of the conduct pre-2011.

Q. So -- so, in other words, what is the link you see between shipments of prescription opioids before 2010 and the increases you observe in illicit opioid mortality after 2010?

A. Well, I'm going to evaluate that for purposes of my analysis on three dimensions. I'm going to look first across states. And I'm going to ask was this states where we saw more shipments in that earlier period the same states where we saw more morality at the later period, right? That is, under the theory that it was the shipment levels that were driving, remember, we're not talking about causality back to distributor. That's even yet further removed.

We're just here looking at did higher shipments associated with more mortality later? Higher shipments before 2010, are they associated with higher mortality later?

A second one is if you look at who is dying, you know, look at like by ages and gender, who is it that's dying in that post-period? Are those the same groups of people who

were taking prescription opioids or abusing prescription opioids in that earlier period? That is, is there somehow to link these two things up either by looking across states or linking them by looking across people? You don't really see that.

And, finally, I'm going to look at this rise in a later period and show that, in fact, it's very different in different parts of the country even though different parts of the country have very similar prescribing behavior early. And that also says there's something else going on here and it has to do with the illicit supply of opioids in this world.

Q. So, let's drill into each of those in more detail, but I first wanted to clarify a point you made just now in your answer, which was you said this is even separate and apart from whether distributors caused the increase in shipments. And could you just explain that again just to make it clear what your analysis is?

A. Yeah, because everything I'm doing right now is just to say is it the same places where there were lots of shipments that have -- in the early period have more mortality in a later period? Is it the same groups who had lots of prescriptions in the early period and who had more mortality in the later period? And are there differences across regions of the country in those outcomes even though they

were very similar in terms of shipment?

So, nothing in there is ascribing why those shipments were what they were in the early period. Given what they were, does that seem to drive the later period?

Q. And so, all of this analysis is based on your earlier discussion about the reasons that shipments increased based on prescribing behavior?

A. Yeah. It would be -- it really is about the outcome. The outcome was driven by prescribing behavior and did that higher prescribing behavior somehow predict what we see later, either cross-sectionally, group-wise, and understand the differences across regions.

Q. So, let's drill into more detail on these three points you've made. First, I believe you said that the data do not show a strong relationship between shipments of prescription opioids in 2000 and increased mortality from heroin or fentanyl later?

A. Right. So, I'm going to divide the world. If we're looking at shipments, I'm going to look pre-2010 and I'm going to measure for each state how much -- how much on a per capita basis there was in terms of shipments. Remember, this is just an outcome.

And then, I'm going to measure mortality in the later period and say is there a relationship there? Do the places have more quantity in the early period the same places that

had more mortality in the later period?

Q. So, let's put up Exhibit 49 from your report. So, Dr. Murphy, maybe we can just take one of these plots and have you explain what it signifies.

A. Yeah. Each state is going to be a dot on this plot, right? So, for each state, we know what the MME shipments were per adult per year, 1997 to 2010. That determines where you are on the horizontal axis.

And then, we look at your mortality rate and, in the left-hand panel, we're looking at heroin mortality. In the right-hand panel, we're looking at fentanyl mortality. And we're asking is there a relationship here? Do we see a relationship between where you are on the horizontal axis and where you are on the vertical axis, which if you thought that it was consumption or quantity in the earlier period that was really an explanatory factor for mortality in a later period, you would expect to see an association here.

And what you really see is a very weak association. In the left-hand panel, the unweighted correlation is .16. The population correlation is .006, essentially 0, but both of those numbers are quite small.

Q. So, let's just go back --

A. And you can kind of see it in the picture. There's not a clear pattern in this picture. It tells you one is strongly associated with the other and, indeed, a

correlation of .16 is -- for this sample size is not statistically significant; that is, it's not something greater than what you'd expect to see by chance, which is the statistical notions of significance.

Q. So, you're referring to these correlation coefficients that are stated up here?

A. Yeah. The .16 on the left and .13 on the right. One way to think about it is .16 is the correlation. You have to actually square that number, which becomes like .02 -- you know -- 256. So, it tells you that about a little -- about two and a half percent of the variation in mortality is explained by shipments. Essentially none. That means 97 and a half percent and, on the right-hand panel, .13 squared is 1.6. 0169, which is less than two percent. It says essentially all the variations not explained by -- by shipments in the earlier period.

Q. So, in other words, the variation, the variation in death rates, is not explained by the variation in shipment rates in the earlier period?

A. Not to any significant extent.

Q. And so, what is that telling you? What conclusion do you draw from this?

A. Well, a story -- again, this doesn't get back to whether it was, you know, distributor behavior, but even beyond that, just saying what is it -- there's a story that

says what's driving mortality in the later period, the level of shipments in the earlier period as an outcome, we just don't see it. It's just not there in the cross-section here.

Q. So, the conclusion you draw is that you can't see a relationship between these death rates in the later period and the shipment rates in the earlier period?

A. I would say it's not just you can't see. You can measure and that's what the correlation does here. And the correlation says there's really not a relationship. And the overwhelming amount of the variations do something else, not the shipments.

Q. So, let's -- let's turn to the next analysis you did. I believe you mentioned that you see age differences between the population that was prescribed opioids prior to 2010 and those who were overdosing from the legal over -- of opioids after 2010. Is that a fair characterization?

A. Yeah. I think it gets at this question, again, of whether there's a link; that is, is it the people who are getting more prescriptions in the early period who then moved over to illicit opioids and were dying from illicit opioids in the later period?

And if that -- you know, a simple version of that story would be you should see the same groups, right? The groups that were getting lots of prescriptions, consuming lots of

opioids, would be the same groups that would show up later.

Q. So, let's take a look at Exhibit 44 from your report. What conclusions do you draw on that issue?

A. Yeah. If you look at prescriptions in the earlier period, again, that's 2001 to 2010, the biggest groups getting the prescriptions were, number one, older women. That's 51 years of age and older. They accounted for 31.6 percent of prescriptions. Older men, 51 and older, counted for 25.3 percent of prescriptions.

And young men and young women accounted for very few prescriptions, only 3 percent for males and another 3 percent for women. So, young people together were like 6 percent; whereas, older men and women were, what is that, 57 percent. So, you know, almost ten times as much prescriptions among the older people as the younger people.

Q. And then, what do you see in terms of the mortality rates in the later period?

A. Well, you see kind of the reverse, that the biggest mortality rates are for the young in this case, where the younger individuals and the middle-age individuals who are the bulk of mortality and the older people account for -- particularly older women, remember, who are the biggest people getting the prescriptions in the earlier period are very much underrepresented in the mortality data.

Q. So, what's the significance of that? What does it tell

you when you observe that the group that was receiving the most -- the highest percentage of prescriptions in the earlier period isn't reflected in the later mortality levels? What's the significance?

MR. FARRELL: Again, as we change to each slide, all I'd ask is, for the record, the geographic scope be defined.

BY MR. HESTER:

Q. What are you discussing here, Dr. Murphy?

A. This is nationwide data for -- we can do mortality state by state, but because of the data we have on the prescriptions, we can't do state by state. So, we were -- we had to do this one at the national level.

Q. And do these mortality figures that you're analyzing at the U. S. level, do you see them as having relevance in West Virginia?

A. Yeah. Because the age patterns you can see, you know, they're not exactly the same, but qualitatively they're going to be very similar. And you would see something similar to this, I believe, if you looked at what -- we know on the mortality side we would see something similar to this and I don't have reason to believe the prescription side would be different.

Q. So, what conclusion do you draw when you see a heavy weighting of older people and the prescriptions between 2001

and 2010 and a heavier weighting of mortality in a younger group after 2010? What conclusion do you draw?

A. It sort of says a story that says it's the people who were getting the prescriptions back then who then shifted over to getting -- to consuming illicit opioids. It doesn't fit the data very well, particularly when you look at the younger group, because a lot of that younger group, you know, the bottom half of that 15 to 30 group were children in the earlier periods. So, they're going to be -- you know, they weren't there at all. So, you know, it does say that that simple story doesn't really fit the data very well.

Q. And when you say the simple story, what are you referring to there?

A. I'm saying the simple story of individuals transiting from -- that what you're seeing in the later period is just the same group of people who used to be getting prescriptions now abusing nonprescription opioids.

Q. Have you also looked at these -- this same point about age differences in terms of overdose levels?

A. I have because, you know, one of the things of looking at prescriptions is you could say, well, geez, those are getting the prescriptions, but how do I know who is actually abusing them? And, you know, that age distribution can be different.

And so, what I did is, I used mortality for both now. I'm going to use mortality, who's dying in the earlier period, and comparing that to who -- the distribution of who is dying in the later period. So, it's getting closer to looking at abuse rather than prescriptions.

Q. So, let's look at Exhibit 47. So, Dr. Murphy, what does this chart show? It's age distribution at the time of death by opioid type. What does that tell you?

A. Okay. This is a little complicated. I mean, I think people are probably familiar with the usual kind of bell curve story. It's just telling you how a population is distributed across ages.

So, for example, the black line in this figure, I'll say this is for the U. S. So, this is for the U. S. as a whole.

The black line in this figure is telling us that the modal level of age is in the -- around age 50, right; that is, the peak of that black line is about age 50.

Q. And when you say the black line, you're referring to the prescription opioid line during that period, 1999 to 2010?

A. Correct. In that earlier period, we're looking now not at who is getting a prescription, but whose overdose deaths, and we're saying the biggest numbers in that period are 50-year-olds, around 50. And, you know, kind of the highest

levels are running, say, in this graph between 40 and 60, whatever you want to say. That's the peak of the black line.

Q. And then, when we look at this, at both the green and the blue lines, those are showing us heroin and fentanyl overdoses, 2010 to 2018; is that right?

A. Right. So, you know, roughly ten years later. Kind of think of it that way. We're looking at what age groups are the predominant among the illicit deaths and you can see that's predominantly to the left.

Q. So, when it's an age group that has an average roughly around what?

A. Well, an average -- you can't -- the mode is about 30, right? The biggest -- what we call the mode, that's where the highest point of this curve is around 30.

But you can see that there's a skewed much more left toward younger ages for the later mortality; whereas, the earlier period mortality was skewed much more right. And, remember, these are ten years apart and people are getting older.

So, if it was the same folks the curve would be moving to the right, not to the left, right? Because, remember, this is -- the green and blue lines, we're ten years later. So, somebody who is at 40 on the black line would be ten years to the right on the green or blue line.

Q. So, what conclusion do you draw from this chart?
A. It's kind of -- it says it sort of similar to what we saw with the prescriptions. There's a difference in the groups, a pretty substantial difference in who is overdosing on illicit opioids in a later period, and who was overdosing on prescription opioids in the earlier period.
Q. So, what does that tell you about this point of transition from prescription opioids to illegal -- illegal opioids?
A. It says it's -- again, it gets -- it pushes against a view that this is really the same population of individuals moving from one to the other.
Q. You also had mentioned geographic differences in opioid and, in particular, fentanyl mortality, I believe; is that right?
A. Yes.
Q. And could you explain that in more detail?
A. Yeah. It turns out that the story of what happened with opioid mortality, in particular, heroin and fentanyl mortality is pretty different in the eastern U. S. and the western U. S.
Q. Let's put up a chart from your report on that. What does this chart reflect?
A. Okay. The chart reflects -- again, it's kind of like the first chart we put up today where we had shipments on

the blue line and we have mortality on the black line. We have the same concepts we used in the first chart we put up.

Q. So, just for the record, could you describe what you show here in terms of states east of the Mississippi and west of the Mississippi?

A. Yes. So the left-hand panel is states west of the Mississippi. If we're measuring shipments per -- per MME per adult year by year in the blue line on the left. On the right we're measuring exactly the same thing, but for the east to the Mississippi River, that's the -- that's the blue line on the right.

And you can see they're not exactly the same, but follows the same general pattern. Both the east and the west, the shipment data rise until we get to about 2010 or '11 and then decline. They're a little higher east than they were west but, you know, the general pattern is very, very similar.

Actually, interestingly, if you look at mortality pre-2010, it's also very similar, that by the time you get to 2010, they're both right around 7 or 8 in terms of mortality.

But then, after 2010, they just behave completely different. In the west, the mortality rises only very slightly. In the east, mortality goes way up, goes from, you know, 7 or 8 up to the 20s. So, very different stories

east and west and mortality, even though they're very similar stories on shipments and, indeed, even though they were very similar stories on mortality prior to 2010.

Q. And so, what conclusion do you draw from this?

A. Well, something else is going on in this period and it's differing a lot between the east and the west and, as it turns out, the most logical one and the one that seems to be supported by the data is it has to do with the nature of the heroin supply in the two parts of the country, that the western U. S. has traditionally been supplied with black tar heroin, which is much harder to cut with fentanyl, and the eastern U. S. is much more powder heroin for which fentanyl is much easier to use.

Q. And so, when you said, Dr. Murphy, something else is going on, something else aside from what? What are you --

A. What I'm saying is it's not the shipment story per se as it is the nature of the illicit drug market and changes in the illicit drug market, and particularly the expansion of fentanyl and the availability of fentanyl, which is much greater in the east than in the west, accounts for the much greater increase in mortality in that greater period.

Q. And so, let's look at Exhibit 42. So, again, here's another take on this geographic variation point. Could you describe what this reflects, Dr. Murphy?

A. Again, remember when we broke out the opioid mortality

rates between prescription opioids and heroin and fentanyl. I did that in my second chart that I had.

This does it separately, exact same calculation, but separately for east and west. And what you see is the prescription opioid mortality looks like -- kind of behaves the same way east and west. It goes up until about 2010 or '11 and then goes down both east and west.

But you see the heroin and fentanyl mortality just goes way, way faster in the west than it does the east and, really, the biggest distinction between the two is that latest period where fentanyl really plays the big role.

Q. And do you have an understanding as to why that would be, why -- why the fentanyl mortality would be rising so much faster in the east?

A. Yeah. It's back to what I said before. It's really the nature of the supply chain in the illicit market, right? It's the illicit market supply chain that's driving that.

Q. And could you describe in a little more particularity what it is about the supply chain that makes fentanyl more likely to be showing up in the east than the west?

A. Yeah. I think my understanding and, again, this has been -- you know, people -- this has been looked at by people in literature, is that it has to do with the nature of the supply chain in terms of the types of heroin that are being distributed in two parts with black tar heroin for

Mexico being the primary supply of heroin in the west and powder heroin, I believe, mostly from Colombia being a supply in the east.

Q. And so, what's the -- what's the significance of powder heroin versus black tar heroin for the fentanyl issue?

A. Well, the economics of fentanyl are a very cheap way for drug dealers to lower -- a way for them to lower their cost is to use fentanyl rather than heroin in their powder. It's much harder to mix the fentanyl in, in the black tar heroin, is my understanding. I'm not a drug dealer, so I can't tell you by firsthand experience, but my -- that's my understanding of how it works.

Q. So, let's -- let's put up the next chart, please. So, Dr. Murphy, this is another chart that's compiled from data out of your report. Could you explain what this one reflects?

A. Yeah. This is heroin and fentanyl mortality east and west of the Mississippi and you really do see that there's a divergence that happens east and west in that post-2011 period.

So, I've got three lines on this chart, the national line which, you know, would be the same as what we had in the first chart we went through today. We have the east, which is the orangish line. And the west, which is the blue line. And you can just see how different they are.

You know, they kind of are about the same in 2010 and really kind of had gone up together through 2010. And then, they just spread apart dramatically afterward.

Q. And you said they spread apart. Can you just, for the record, describe what happens after 2010?

A. Yeah. The heroin and fentanyl mortality in the west rises from, you know, let's say 3, a little less than 3 in 2010. In the west, it goes up to, reading this chart here, 6 and a half or so. And nationally it goes up from about that same level to, you know, 13 and a half. And in the east it goes up to, you know, 19, over 19.

Q. So, what's the significance of these geographic variations? What does that tell you, Dr. Murphy?

A. It highlights the importance of the illicit drug market in driving the increase in mortality in that later period. It really highlights the role that the illicit drug market played.

Q. And do you see it as contradicting the simple story of a transition from prescription to illegal drugs?

A. I would say it -- it's kind of -- it kind of tells you that there's something else going on. It's not saying that that couldn't be anything. It's just saying if you want to understand this later period, you've really got to look at the illicit market.

Now, when you combine it with the other pieces of

information, right, the other -- I take the first one where I had the scatter chart across states. Combining all of these together says, look, earlier supply doesn't seem to tell the story on any of these dimensions. It doesn't tell you which states. It doesn't tell you which individuals. And it doesn't explain the biggest difference we see, which is geographic.

Q. Now, we were discussing this point about the differences in the ages between the people who had either received prescriptions for opioids or had overdosed on opioids during the earlier period up to 2010 and the later period of looking at both overdoses and for heroin and fentanyl. Does that point -- that point was based on national data; is that right, Dr. Murphy?

A. That was based on national data.

Q. Now, would you -- would you view that point as applying to West Virginia?

A. Like I said, I can't do the prescription one for West Virginia, although I would have viewed it as applying. You can do the age one for West Virginia. You would have some issues because data suppression in CDC WONDER, but when you do that, you see that same -- you see kind of qualitatively that same distinction with a shift left in the distribution in a later period to younger ages in West Virginia. It's just harder to do because you have less data.

Q. So, what's the conclusion out of these three factors? What's the conclusion you draw about the story of a transition from prescription opioids to illegal drugs?

A. The economic evidence doesn't fit that story very well at all. That, you know, like I said before, it's not in the same states. It's not in the same groups. And the big distinction we see east and west doesn't seem to be explained by that.

Q. Let me shift gears, Dr. Murphy, and talk about Dr. Keyes and her OUD methodology. Are you familiar with the analysis that Dr. Keyes engaged in to estimate an OUD population in Cabell County and the City of Huntington?

A. Yes, I am.

Q. And have you reviewed her testimony and work papers on that issue?

A. Yes, I have.

Q. And based on that review, have you come to an understanding at a general level as to how Dr. Keyes purports to estimate the prevalence of OUD in Cabell-Huntington?

A. Yes, I have.

Q. And can you describe for the Court at a general level how Dr. Keyes estimated the prevalence of OUD in Cabell-Huntington?

A. Yeah. What she attempted to do was use the number of

drug overdose deaths together with a mortality rate to calculate an implied population at risk; in this case, an implied OUD population.

Q. And would it help you to explain your point to work on the board for a minute?

A. It sure would. It would put me back in a much more familiar setting for me.

MR. HESTER: Your Honor, may Dr. Murphy approach the board?

THE COURT: You may step down, Dr. Murphy. Put on your teacher hat.

THE WITNESS: Yes.

Uh-oh. I'm used to blackboards, so this is high tech for me.

MR. HESTER: I'm going to erase it for you first.

THE WITNESS: You even have an eraser? How are you going to erase it? This is fancy.

MR. HESTER: Nice, huh?

THE WITNESS: We don't have these in Chicago. I always use a chalkboard. All right. So --

BY MR. HESTER:

Q. Okay. So, Dr. Murphy, why don't you explain your understanding of Dr. Keyes' methodology?

A. Yeah. I'm going to start, actually, predicate of that methodology. So, if you think about just the simple kind of

mathematics of it, you can think of deaths for a group, whatever group you're looking at, would be -- should be equal to the population in that group times the mortality rate in that group, right?

So, if I had a population of a million people and I had a 1 percent death rate, I could multiply a million by .01 and I would say I expect 10,000 deaths. That's just -- it's really arithmetic, right? It sort of says this is population times the death rate should give me the number of deaths. And, in fact, if you constructed your death rate from this data this would hold exactly, right, because that would be the definition.

Now, you can reverse this same equation using algebra and re-write this as deaths divided by the mortality rate should be equal to the population. The same equation just re-written by saying, okay, I can infer the population if I know deaths for that population and I know the mortality rate for that population.

You know, now, what's important is that when you do this, you have deaths corresponding to the population you want and you have the mortality rate corresponding to the population you want.

If you got the wrong number of deaths, because you look at deaths for a different population, you're not going to get your population back from this formula. And if you have

the wrong mortality rate, you're not going to get the population back.

Q. And based on your review of Dr. Keyes' work and her work papers, do you have an opinion as to whether she reliably applied this methodology?

A. No.

MR. FARRELL: Judge, I'm going to place a preliminary objection on foundation. Again, from an economic standpoint, I don't think there's any standing to argue with the University of Chicago professor, but for purposes of the Economics Department of Chicago criticizing the Epidemiology Department of Columbia, I think we're getting ready to start a war.

THE COURT: Well, I -- I'll overrule your objection. You can cross examine him on this, Mr. Farrell, but I don't --

MR. FARRELL: Yes, Your Honor.

THE COURT: I'm going to let him go ahead. Go ahead, Dr. Murphy.

BY MR. HESTER:

Q. Yes. Go ahead, Dr. Murphy.

A. You know, I think the algebra works the same in economics and in epidemiology. They're both based on mathematics and this is -- as you can tell, this is pretty straightforward math.

Q. And let me ask you a question just to put that in context. As an economist, do you undertake this kind of effort to estimate populations? Is that something you do in your work?

A. Sure. We do this all the time. We're trying to estimate something, an input from an output or an output from an input. You just do exactly this. If you know every unit of input produces ten units of output, then you can say, you know, input times how many units they produce should be output and vice versa.

And if I know the output, I can say how much input do I need by dividing.

Q. And so, I had asked you, did you reach an opinion about the -- about whether Dr. Keyes reliably applied this basic algebra to come up with an OUD population?

A. I did. And like I said, to make this work, you need to have deaths for that population because if you have a different number of deaths than the deaths that came out of that population, obviously, this formula won't hold anymore.

And if you have the wrong mortality rate, then this formula is not going to be reliable either.

So, if you mess those up, there's going to be a problem.

Q. So, let me have you go back now, Dr. Murphy, to your seat and I'll ask you a few more questions about that.

So, Dr. Murphy, you made the point that the methodology depends -- the methodology for estimating the OUD population depends on the accuracy of the death number and the mortality rate. Did you reach a view as to whether Dr. Keyes got these numbers right?

A. Right. Again, it's important. It's not that you have a death, the right number of deaths. You have to have the deaths for that population that you're trying to estimate and you have to have the mortality rate that applies to that population you're trying to estimate.

So, it's not just that you have the right number of deaths from some other calculation. You need the right number for this calculation, which means the deaths and the mortality rates have to correspond to the population.

In this case, we're interested in estimating the OUD population, so we need to have deaths for that population and the right mortality rate for that OUD population.

Q. And did you reach a view as to whether Dr. Keyes came up with the right death number for that estimation of the OUD population?

A. I did. She -- she used all overdose deaths, which would include people who don't have OUD. So, she's got deaths in that death number that don't correspond to the population she's trying to estimate.

Q. What's the significance of that point?

A. Well, as the formula kind of shows you, if you put too many people in the death category, you're going to get too many people implied in that population, right, because if you're 10 percent too high on the deaths, you're 10 percent too high on the population. It just carries straight over.

Q. Is it reasonable to assume that anyone who overdoses from any drug has OUD?

A. No. It's certainly -- you know, somebody who overdosed -- there's no reason to presume somebody who overdosed on a non-opioid has OUD, but even there are going to be people who overdose on opioids that don't have OUD.

Q. And does Dr. Keyes provide any support for the assertion that everyone who overdoses from any drug has OUD?

A. No.

Q. You also testified that Dr. Keyes made an error in the denominator in the mortality rate; is that right?

A. Yeah. She made several errors, actually, in calculating the mortality rate.

One is she tries to calibrate the proper mortality rate for the population using a calibration exercise based on heroin and fentanyl deaths between 2011 and 2015, but she doesn't do that correctly because she -- she comes -- she basically looked at data and said that the death rate for illicit opioids tripled over this period and then uses 3 as the multiple for fentanyl mortality relative to -- to

non-fentanyl mortality basically in her formula.

But because 2015, not everything was fentanyl, that's going to tend to underestimate the higher lethality of fentanyl because, you know, it would only be equal to the fentanyl mortality if you had a hundred percent shift. So she's kind of missed on that one.

And then there's some other details of how she didn't do it correctly either but, you know, that was probably the biggest one on that dimension. So, mis-calibrated to the 2011, 2015 data.

And then, secondly, remember, I said you have to have the right mortality rate for this population. And she's applying this to deaths in -- in West Virginia, Cabell County, and she's -- and, therefore, she's trying to estimate the population of OUD in Cabell County.

In order to make this formula work, you have to have the mortality rate for Cabell County for that population, right? It doesn't work if you have the national one or something that doesn't fit.

And because fentanyl grew much more in the east than in the west, the mortality rate in Cabell County is higher than you would think based on places where fentanyl was less part of it.

Q. And does that point that you're making go back to the graphs we looked at before where you showed that the level

of fentanyl mortality was much higher in the east of the Mississippi states versus west Mississippi?

A. Yes. And, in fact, if you do that calculation that she did, it's not the right calculation. So, if you just say I'm going to do what she did and I'm just going to fix that and I'm going to use 4.6 as the number which you would get in the east of the Mississippi rather than 3, right, that would be just fixing one.

You haven't fixed the numerator. You haven't fixed deaths. You haven't fixed all this calibration stuff. You just say I'm just going to change and say, look, the number you need to use to fit the eastern data is much greater than you need for the national data. So, I'm going to use 4.6, which is the eastern number, as opposed to 3, which is the national number.

Then what you do is, remember, she estimates, I believe, 8252 as the OUD population. It goes down to like 5496.

Q. Now, I want to go back to that calculation in just a minute, Dr. Murphy, and make sure we got that right, but at a high level, first, is your view that the -- the errors by Dr. Keyes affected both the deaths and the mortality numbers that she relied on to estimate the OUD population?

A. Yeah. Her methodology overstates deaths, which is going to push you toward higher population. Now,

overestimating the population and she tended to underestimate the mortality rate, which also goes in the same direction of pushing the population up.

Q. So, what's the net effect of those two errors that you believe in terms of her OUD number?

A. The population she estimates is going to be too high as a result of making errors in both increasing what we call the enumerator, the top number, and decreasing the denominator, or the bottom number.

Q. So, I want to go back now to this point you made about the corrected calculations. Let's put aside these flaws of -- the broader flaws of methodology you've discussed and let's talk just about the fentanyl adjustment that Dr. Keyes made.

Can you describe what she did? What was her methodology?

A. Yeah. It's fascinating. She wasn't clear about what she did in her report, but, I mean, I think it was clear from her testimony she went to I think it was about -- I can't remember who the paper was. She went to a paper and she looked at illicit opioid mortality nationally and how it changed between 2011 and 2015.

Q. Is that Dow (phonetic) you're thinking of?

A. Yeah, Dow. I knew it wasn't Powell. That's another person. But it was Dow, that's correct.

And she estimated it. It roughly tripled over that time period and she says, okay, I'm going to use that as the effect of having a fentanyl in the supply rather than non-fentanyl supply.

But then, when she applies it in her formula, she does it in a way that would imply that that's the number associated with fentanyl compared to non-fentanyl, which it wouldn't be, because 2015 it wasn't a hundred percent fentanyl. So, you know, the overall number is going to be a weighted average. So, you would need a higher number for fentanyl to fit the 2015 data if you did it correctly.

Q. And that's --

A. Now, she does a bunch of other stuff that's not right either. She got weights by deaths instead of weights by populations. And there's a lot of things that she kind of messed up.

But if you just fixed that one, if you just said, look, I'm going to do what she did and I'm going to put 4.6, the number for the east rather than the 3 is the number for the west. So, you haven't fixed even the way she did it, just the number she plugged in.

Q. So, you're using this number 4.6. Where do you derive that?

A. That's just to her methodology, but focused on the east rather than west because, if you're going to calibrate out

for 2011 to 2015, remember, we need the mortality rate for this population. We don't need the mortality rate for a different population.

We need a mortality rate for the folks in West Virginia if you're going to estimate OUD in West Virginia. And a better estimate of that is going to be the eastern number than it is the national number.

Q. And where -- and where does that 4.6 come from? Where does that eastern number come from?

A. Do exactly what she did. Just estimate how much that mortality went up between 2011 and 2015 and use that number.

Q. And so, if you put that 4.6 number in instead of the 3-times multiplier she used, what is the number that you come up with in terms of an OUD?

A. I remember -- I believe her number was 8252. I think the corrected number, just correcting that one thing, would be 5496.

Q. And roughly how much smaller is that than Dr. Keyes' estimate of the OUD population?

A. About a -- almost a third. About a third.

Q. Now, do you believe that that number that you just gave us, 5496, is a reliable estimate of the OUD population of Cabell-Huntington?

A. I don't think it is because we've still not corrected the other flaws. We haven't corrected the deaths in the

numerator and we haven't corrected the other methodological flaws in how she created her mortality rate.

Remember, all this depends on getting the right deaths and getting the right mortality rates. If you don't have them both, you're bound to not get the right answer. And I think, just as that 4.6 number shows, it can lead to substantial differences.

Q. So, but you're applying the 4.6 number the 5496 OUD population that you've just given us? That assumes all of the other elements of her methodology?

A. Correct. I just replaced number 3 with 4.6 in her exact formula.

Q. Do you believe that that OUD number, 5496, is more accurate than Dr. Keyes' estimate of 8252?

A. I would believe it would be more accurate, but it wouldn't be something that I would be willing to rely on as a -- as a number.

Q. As an economist, what conclusion do you draw from the fact that making one adjustment like this in one assumption on the geographic nature of fentanyl changes the OUD estimate that much?

MR. FARRELL: Judge, I do think now we're probably getting beyond the --

THE COURT: Yes. Do you want to remove the --

MR. FARRELL: Well, that, too.

THE COURT: I didn't understand what you said, Mr. Farrell.

MR. FARRELL: Well, I think that now, this last question, I think we now have gone beyond into the field of epidemiology and that may be improper.

MR. HESTER: I mean, Your Honor, I was asking Dr. Murphy his view as an economist.

THE COURT: Yeah. Overruled. I will allow it. Go ahead.

BY MR. HESTER:

Q. Dr. Murphy, from your perspective as a professional economist, what conclusion do you draw from the fact that changing one assumption like this alters the estimate in this -- by this magnitude?

A. Well, I think it's an illustration of how much those assumptions matter. I mean, you know, sometimes you can have an economic model or, you know, a model that's not limited to economics in which changes in assumptions don't matter very much. They somehow -- you know, they -- they're not really a key driver of the output.

And what you illustrate with that example is that that assumption in particular, which is not different than a lot of the other elements of her analysis, has a substantial effect. So, you worry that you got the numbers right.

Q. And so, does that bear on your judgment about the

reliability of her estimates?

A. Yeah. I think it would say given that I know that there were a lot of things that were not done correct [sic] and we really don't have the deaths or the mortality rate for the population you're trying to estimate, I don't see how you can make a reliable estimate.

MR. HESTER: Thank you, Dr. Murphy.

I'll pass the witness, Your Honor.

THE COURT: Okay. You may cross examine.

MR. FARRELL: Judge, is it possible for us to take a five-minute break?

THE COURT: Yes. I think the court reporter will appreciate that, too. Five minutes.

(Recess taken)

THE COURT: Okay, Mr. Farrell.

MR. FARRELL: Thank you.

CROSS EXAMINATION

BY MR. FARRELL:

Q. I introduced myself briefly. My name is Paul Farrell and I've got some questions for you. Well, lesson number one that I was taught by my elders is never debate economics with an economist. So, what I do have is some general broader questions that I want to walk through with you.

The first thing is, I went and typed in supply and demand for kids and I came up with this graph.

MR. FARRELL: Can you put it up, please? The supply and demand with the equilibrium, please. No, the one before that. Yeah, this one.

BY MR. FARRELL:

Q. So, I promise I'm not going to embarrass myself by going into too great detail, but I am trying to understand your viewpoint as an economist in this case.

So, would you describe for the judge in general what this is?

A. Well, as it's stated, it is a supply and demand diagram. So, it says the quantity we get in the equilibrium depends on the willingness of sellers in this case to supply the product to suppliers and the willingness of buyers to buy the product, which is the demand side.

So, you know, we usually think of, you know, maybe this is gasoline and this is, you know, a quantity of gasoline on the horizontal axis. Demand would be driven by how much people want to drive and, you know, fuel economy of cars and all kinds of things like that.

And the supply side would be determined by, you know, availability of petroleum and the costs of refining and things like that.

Q. So, in general, the blue line is the supply line, correct?

A. That would be what we call supply curve.

Q. Supply curve. And it has a little bit of elasticity to it?

A. It does. And it depends on -- how much elasticity depends on lots of factors you can study in different markets.

Q. So, I'm hoping to get some brownie points with the terminology. But, in general, the supply curve on the bottom, suppliers are willing to supply more quantity the higher the price. Is that in general?

A. All else equal, yeah. I mean, you've got to be careful to say why is the price higher but yes. I mean, all else equal, suppliers will be more willing to supply the higher the price.

Q. And, in general, consumers, or the people that are demanding, they're willing to buy less the higher the price?

A. That generally is true, too. That's kind of called the law of demand.

Q. And somewhere in between these two intersect in the absence of government oversight in laissez faire economics and they intersect at a natural market at an equilibrium price, correct?

A. Yeah. Equilibrium would extend even if, for example, there were taxes or other government interventions, they might affect supply and they might affect demand, but you still think there's an equilibrium, even when the government

is intervening. It's just a different equilibrium than you would have absent government intervention.

MR. FARRELL: Now, could we go to the next slide?

Q. So, what I wanted to try to illustrate here is this is the supply, but I've taken out the demand because the demand for those that are addicted is a little different, is it not?

A. Well, what do you mean by different? I mean, it still obeys the law of demand. I mean, it still -- it still obeys that they buy more when the price is lower and they buy less when the price is higher.

In fact, the empirical evidence on addiction is elasticity, it's not clear whether it's more elastic or less elastic honestly.

I've actually written on this and Gary Becker and I published papers on addiction. So --

Q. I'm aware.

A. Okay.

Q. In fact, you've said that there is more -- I'm not saying absolutely an elastic, but you have said in your papers that there is some inelasticity based on the nature of addiction?

For instance, let me say it in a different way. If you're addicted to opium you're probably going to want to get your fix or get as much as you can no matter the price

until some ceiling, which makes the line maybe a little more like that.

MR. HESTER: Your Honor, object to form. That's a -- that's a long talk before a question.

THE WITNESS: I would say having studied addiction, I don't think that's what the picture looks like.

BY MR. FARRELL:

Q. Okay.

A. If you look at cigarettes, it doesn't look like that. We've done some work on -- on illicit drugs. They tend to be inelastic, which means their elasticity is less than 1, which means a 10 percent increase in price leads to a less than 10 percent reduction in quantity. But that's not unusual for non-addictive drugs.

For example, gasoline demand is very inelastic. That's more like .1. It would be less than the elasticity of many addictive substances.

So, I don't think -- you might want to say they relatively tend to be inelastic, but that's not unusual. All kinds of commodities have relatively inelastic demand.

Q. So, let's just take, say, heroin. Let's take an addicted person to heroin or opium. What would the demand curve look like?

A. It would be downward sloping. They would consume more MMEs as MMEs get cheaper. And it wouldn't -- it would not

look like the one you drew because it wouldn't show a very low price responsiveness typically.

Q. So, what would it look like?

A. It would -- it would tend to be like the standard demand curve downward sloping. That, you know, people use more as MMEs get cheaper.

That work's been done. A colleague of mine, Casey Mulligan, for example, has done a lot of work looking at how the price per MME has affected consumptions of MMEs and he's -- you know, his analysis shows there's a significant price response.

Q. And so, that's one of the points that you've made in your papers, is it not, for the economic justification for legalizing illicit drugs; is that fair?

A. Well, I think you're overly simplifying what we said.

Q. I'm sure I am.

A. I think we compared -- I think what we said is you might want to make them legal and tax them rather than make them illegal and have them taxed implicitly through violence, and crime, and all those other things and having them less safe because they're available on the streets.

And, you know, we saw that with prohibition. I mean, we have prohibition on alcohol. It was just tremendously disruptive. And there are lots of costs of having them illegal.

I'm not saying you want to make them cheap and widely available, but you don't -- I mean, illegal prohibitions, ineffective prohibitions, are very costly because you end up with all of these ancillary costs.

And, more importantly, you know, they end up being ineffective. They're not great at reducing quantity. At the same time, they're good at increasing lots of costs.

So, you know, we haven't had a great experience with the war on drugs in my opinion. I think -- and people are beginning to realize the kind of costs we've had. That doesn't say you want unfettered access to things, but it says the current methodology we're using isn't very effective.

Q. And so, Dr. Murphy, let me see if I can be a little more concise. You've written an article for The Wall Street Journal and published at least three different times an economic model suggesting that rather than arrest our way out of the problem, it may be more beneficial to legalize illicit drugs and regulate them; is that fair?

A. I think that's right. I think you would avoid the kind of death rates we see today with illicit fentanyl where, you know, people aren't out there trying to die by and large, but because of the way they're supplied in a market that -- you know, where you have people buying things from -- they have no recourse through the courts or anything else because

they're engaged in illegal transactions. The costs on the consumers, as well as the communities and suppliers, are going to be high. And that's why you want to get out of that.

Q. Right. And so, I read your Wall Street Journal article, but it's based on your papers and your papers use an actual economic modeling system to make your point; is that fair?

A. That is true.

Q. And it has a lot of formulas in it and it's pretty complex but, theoretically, economists can come up with modeling for this?

A. You can, but it's not just theoretical. I mean, it's really -- a lot of it is empirical.

It's actually saying, look, I can link the theory to the data. I can actually see the consequences of how a -- how a prohibition market works.

I can see the fact that the products that people get are of inferior consistency and quality to what they would get in a more standard marketplace. I can see that the violence associated with contract enforcement or the lack of contract enforcement in the illicit markets is a huge problem.

You end up with all of these people in prison. Costs them to be there. Costs us to put them there.

We have communities and countries kind of destroyed by the illegal nature of the product. And those are high costs that we pay as a society and as a -- really, as a population in the world.

Q. Now, you also have noted in your writings that there's probably some political opposition to legalizing illicit drugs; agreed?

A. Oh, there is, although less. I mean, you know, it was -- you know, if you thought about, you know, 30 years ago or 40 years ago, it wasn't very many people who, you know, even thought marijuana should be legalized, right? We're moving in that direction.

Guys like Milton Friedman were like, hey, you know, this is a very costly system we have here and he was -- you know, for long in that direction.

I mean, Gary Becker and I at the university and George Schultz, who passed away recently, who was a good friend of mine and Gary's, you know, these are all people who fought thinking about these issues, seriously was a good idea that -- that it was a way to potentially -- not that we wouldn't be better off in a world where people didn't abuse drugs and things like that. It's just, if you want to get there, the way we're trying to get that isn't very effective.

Q. So, let me see if I can jump to a real quick topic here. So, I'm going to try to take a non-graphic model and

just talk about supply and demand of opioids, right?

You've testified you have some basic knowledge but, in general, you can't get addicted to an opioid unless you are exposed to an opioid; would you agree with me?

A. Yes. I mean, to consume an opioid you have to consume it and generally it's hard to get addicted to something without consuming it first. Addiction tends to follow consumption.

Q. Okay. In this instance, it's impossible to get addicted to opioids unless you have been exposed to opioids; agreed?

A. I think that's right. I'm not a doctor, so I can't say, but that's my understanding of how it works. It's addictions driven through past consumption.

Q. Okay. So, if you supply somebody with an opioid and they consume it and become addicted to it, that also tends to generate demand; would you agree with that?

A. Well, it generates -- it could generate future demand; that is, there's some feedback effect, but past demand would also generate future demand. Again, it's consumption that generates future demand, not supply. Right? It's consumption that generates future demand in an addiction framework.

Q. So, instead of demand, if we just put here "patient", and instead of supply, we put a "pharmacy", right, what I

want to ask you is this -- you're shaking your head no.
A. I don't -- I don't see how those are analogous, how pharmacies telling me just about supply and how a patient is telling me just about demand. So --
Q. Well, I'm attempting to change the diagram. The pharmacy supplies pills to patients, correct?
A. Yeah, but not in the economic sense. I mean, they're not the determinants on the supply side, right?
Q. Yeah. So, this is where I'm going with this. I'm trying to go through the closed chain of distribution in the Controlled Substance Act and you're here today talking about supply and demand from an economic standpoint and what are the driving factors as if we're in graduate school at the University of Chicago studying markets; agreed?
MR. HESTER: Your Honor, I object to the question. It's just argumentative.
THE COURT: Sustained.
MS. HARDIN: Join, Your Honor.
THE COURT: Sustained.
MR. FARRELL: I thought it was a pretty good argument.
THE COURT: Well, but --
BY MR. FARRELL:
Q. So, in general, you understand that patients go to pharmacies to get their prescriptions filled?

A. That's true.

Q. And in order to do so, they have to go see a doctor first and get a prescription? You understand that?

A. Yes.

Q. And that pharmacies have to buy their pills from distributors? Do you understand that?

A. Yeah. I mean, although it's a little complicated because the pharmacies also have deals with the manufacturers, right, because --

Q. Well, it's just --

A. No. I'm just saying the distributors in this industry are a little different than distributors in other industries because the pharmacies actually have direct relationships with the manufacturers and the distributors really handle the distribution part, not the contracting part often with the pharmacies. I think that's a little different than, for example, most wholesale distribution models.

Q. Agreed. I'm not going to dispute any of that.

Here's the point that I'm going to try to make. Have you made any attempt to assess in your analysis the duties imposed by the Controlled Substances Act between the distributors and the pharmacies?

A. I have not offered an opinion on the regulatory environment or the legal. Those are outside of my areas of expertise.

Q. One last follow-up on this. If we have the supply and demand and let's just say that here's the demand and here's the supply, is there some terminology in economics where the federal government, through regulation or otherwise, comes in and tries to limit the amount of supply -- that's not working very well -- tries to limit the amount of supply by putting some type of cap on it?

A. Sometimes, but that would be a price cap, the way you're drawing it, I think, but yeah.

Q. Okay. Well, how would you account for the supply and demand in the field of opioids for the government's rules for the distributors to block suspicious orders? How would you account for that in economic terms?

MR. HESTER: Object to form, Your Honor.

MS. HARDIN: Same, Your Honor.

THE COURT: Yeah. I think the question is confusing, Mr. Farrell. I'll sustain the objection.

BY MR. FARRELL:

Q. Is there any way for an economist to build into your analysis rules on what limits supply?

A. I would say yes, that economists can look at -- so, for example, we know here that the drugs that were delivered were delivered pursuant to prescriptions.

THE COURT: Mr. Farrell, how much more are you going to have?

MR. FARRELL: We can take a lunch break.

THE COURT: We can what?

MR. FARRELL: Take a lunch break.

THE COURT: Well, are you going to have -- we're not going to be able to finish with Dr. Murphy in the next few minutes, are we?

MR. FARRELL: If you give me a few seconds to whisper, I'll have a few questions.

THE COURT: Do you have any re-direct at this point, Mr. Hester?

MR. HESTER: Not at this point, Your Honor.

THE COURT: Okay. Maybe we can finish up here.

(Pause)

MR. FARRELL: Judge, I'm advised we should take a lunch break.

MR. HESTER: Your Honor, there is one thing I should say, though. Dr. Murphy has a commitment in another matter where he has to testify tomorrow and I assume you're not going to go the full afternoon, but I wanted to check.

MR. FARRELL: I'm certain of it.

THE COURT: What is the time you're trying to get out of town, Dr. Murphy?

THE WITNESS: I have a flight at 6:00 p.m.

MR. HESTER: So, I think we're fine, as long as it's not going to be a long process.

THE COURT: Okay. I'm going to ask you to come back at 2:00, Dr. Murphy, and we'll be in recess until 2:00.

(Recess taken)

THE COURT: Good afternoon, Dr. Murphy.

THE WITNESS: Good afternoon, Your Honor.

THE COURT: Okay, Mr. Farrell, you may continue.

MR. FARRELL: Can we bring up the Exhibit 1 from the demonstratives the defendants used, please? There we go.

BY MR. FARRELL:

Q. Dr. Murphy, I have a couple of questions, and some of this is just orientation to make a couple of subtle points. This is Exhibit 26 from your report and I want to first come over here and I'm going to draw a little square around MME per adult. Do you see that?

A. Yes, I do.

Q. Okay. What's your understanding of what MME per adult means?

A. It's a morphine equivalent measured on a per adult per year basis. So, it's --

Q. And this is -- would another word be -- for it the weight of the drug or how much of the -- of the morphine milligram equivalent is present?

A. Yeah. It's the equivalent amount of weight measured in morphine equivalence. So, it's not the weight of the actual

drug. It would be translated to morphine equivalence weight.

Q. And this comes from the ARCOS data, correct?

A. That does come -- well, yes. The blue line comes from the ARCOS data.

Q. And so, this would be a measurement, for a lack of a better word, of volume? Would you agree with that?

A. It would be a measure of volume, right. There's other things you could do, but I think this has become kind of the most common measure of volume for this marketplace.

Q. And so, in particular, what you've measured here is prescription opioid by volume; agreed?

A. For West Virginia by year per -- measured on a per adult basis.

Q. Yes, sir. And then the line though here, this line, this black line, is all opioid deaths; agreed?

A. That's correct.

Q. So, it would include prescription opioids and, say, heroin or fentanyl?

A. Yes. It would be all opioid deaths, as well as combinations of those, like I talked about earlier.

Q. And so, the purpose of this graph is to demonstrate that there was a period of time where the volume of prescription opioids into West Virginia correlated to a parallel track of opioid deaths, more or less; agreed?

A. Yeah. They were both going up in that earlier period. Parallel is harder to say from this graph, but they were both going up.

Q. And so, here's ultimately, I guess, what my question is. Right here at this point, this inflection point, you'll agree with me that something happened?

A. Well, yeah. I mean, but you circled that whole later period. So, the point at which something happens is kind of where things turn. Not where they cross. I don't think where they cross is of particular significance.

Q. So, somewhere in here?

A. Well, which line are you referring to, the blue one or the black one?

Q. Well, I think I'm just talking about in general, that the prescription opioids are going down and the deaths are going up. They've changed courses. Something has changed.

A. Right. The only thing I was referring to is usually when you talk about an inflection point, it's not a range. It's a point.

Q. Yes, sir.

A. So, you would typically say there was some kind of inflection. That term is misused because, in mathematics, inflection actually means something different.

What we're really talking about is the turning point in that blue line from rising to falling. And then, the black

line is kind of an acceleration that happens in that black line later.

Q. So, my question to you is this. Do you believe that people addicted to prescription opioids have been transitioning to heroin?

A. Some have, but not as a population as a whole. There have been some people transition.

Q. Is this from -- from your personal knowledge or from your academic knowledge as an economist?

A. This would be from reading the literature out there and looking at the data. The data I analyze in my report doesn't specifically follow individuals, although a lot of the papers and other things I've looked at in the academic literature look more at individuals. And you do see some individuals moving across those categories.

Q. So, you understand, sir, that there is testimony and scientific literature in the record to suggest that there is a strong correlation between prescription opioid misuse and the initiation of heroin?

MR. HESTER: Object on foundation grounds, Your Honor.

THE WITNESS: Most of the studies don't actually look at that.

THE COURT: Just a second.

I'll overrule the objection. Go ahead.

THE WITNESS: I'm sorry. I'm sorry. I should have waited.

Most of the studies that I look at don't really look at that correlation. They actually look at people who initiate heroin and ask what fraction of those previously used prescription opioids, which is not an association, right? It's -- because it's not how is one related to the other. It's just a conditional probability in that direction.

Q. So, you understand that the medical literature and the testimony that has been introduced in this court is that four out of five heroin users previously used or abused prescription opioids?

A. It depends on what time period you're looking at. That's changed dramatically, for example, in recent years where a lot more people are initiating on heroin now who haven't previously used prescription opioids.

Q. And you --

A. So, you've got to be careful in terms of what time period you're talking about.

Q. Yes, sir. All right. So, let me change it around and put it in a different perspective just to make a theoretical point. I would like for you to assume that four out of five people that use heroin started out on prescription opioids. Can you assume that for me?

A. Please define what you mean by started out. That's the

first drug they took?

Q. All right. And so, let me start it another way. I want you to assume that there is a relationship, a gateway, a transition, between abusing prescription opioids and using heroin. I want you to assume that as a fact, okay?

A. Define what you mean by gateway because it's been used and misused in these discussions. So, you need to define what you mean by gateway.

Q. Yes, sir. We've had about 30 days worth of debate on it and I fully understand that. What I'm trying to simply do is have you assume that the body of evidence or the argument establishing a gateway effect is, in fact, true. It doesn't mean you have to agree with it. I just want you to assume that as a fact.

A. I just want you to define when you say the evidence has found a gateway. Tell me what you mean constitutes a gateway. Does that mean if you're saying -- are you saying a number of the people who start on heroin have previously used prescription opioids? In no scientific sense would you say that's a gateway. If that's what you mean by gateway, that's not a gateway.

Q. Yes, I understand. I want you, whatever framework you want to use for gateway, whatever level of evidence, I want you just to assume for a moment that people that use prescription opioids are going to end up using heroin.

How's that?

A. Okay. That's counterfactual, but --

Q. It's theoretical and it's hypothetical. If that's true, then you would also agree with me that -- from your testimony that the heroin east of the Mississippi is more likely to have fentanyl; agreed?

A. I think in recent years, in particular. It wasn't true always, but in recent years, more likely than heroin east of the Mississippi would contain fentanyl.

Q. And I want you to assume that fentanyl laced heroin is causing fatal overdoses, particularly east of the Mississippi. I want you to assume those three facts.

My question to you, sir, is if you assume those three facts are true, does that not, in fact, explain the change in the trajectory on Exhibit 26?

A. I -- you're asking does that explain the actual world or could you construct a world where that would happen?

Q. I'm just asking you. You said that something happened. There's lots of factors involved. And I'm asking you, if you assume those three facts to be true, whether or not that is an explanation for the change we see in Exhibit 26 between the volume of prescription opioids and the number of fatal overdoses from opioids?

A. I would say you could construct such a world. I don't think it fits the actual world. That's -- there are too

many other things that don't fit with that.

MR. FARRELL: Can we go to Slide 5, please?

BY MR. FARRELL:

Q. So, I wanted to discuss with you very briefly again the scatter diagram and to make sure that we are on the same page.

This is heroin mortality between 2010 and 2018 on the left and fentanyl mortality between 2013 and 2018 on the right by state, correct?

A. Those are the vertical axes. The horizontal axes are the -- in both cases are what it says.

Q. And so, what your ultimate point here is, is that if you take the average prescription opioid shipment over time and put it on a scatter diagram with the number of deaths, you're saying that the disparity or that the spread of this data indicates a weak association? That's your ultimate point, correct?

A. Yeah.

Q. So --

A. Not just the dots, but the statistics both suggest a weak association.

Q. Yes, sir. In economic terms?

A. Probably more statistical terms, to be honest, but yes, we can call it economics.

Q. Yes, sir. But, ultimately, if you take the dot here

for heroin mortality what we can draw from this is that West Virginia is at the higher end of the rest of the country for heroin mortality; agreed?

A. Yes. You know, I don't know what number it is. Over this period, on average, it was in the top group.

Q. And the same thing over here with fentanyl, is West Virginia is at what appears to be on your graph the second highest fentanyl mortality in the country; agreed?

A. That's what it appears. I believe that's correct. That's what it says in the graph.

Q. Now, if we go to the next slide, which is Page 6, and the last -- the last one that we'll discuss, and I'm not going to bother erasing it because I know I'll mess it up. But in general -- I wrote this down.

Correct me if I'm wrong, but what you are -- is the purpose of this slide or is it your testimony that the people that are getting the pills are not the people dying from the pills? Is that a fair assessment as to what your opinion is today based on the statistics?

A. Well, in this graph, we're looking at people getting the prescriptions and people -- in that previous period and people dying from illicit opioids in a later period. That's how I would put it.

Q. So, let me rephrase it. The people that are getting the prescriptions are not the people that are dying of

opioid overdoses later? That's your -- that's your position?

A. Yeah. I mean, that was paraphrasing, yes.

Q. So, could it also be, in a theoretical sense, could an explanation for that be that the pills that people are getting by prescription are diverting it to the black market? Is that a theoretical possibility?

A. It is. That's why I did the other graph.

Q. And so, is that not just a theoretical possibility but, in fact, is that your -- your conclusion as an economist that the pills, the prescription pills that were given to patients with prescriptions in their hand, were more likely than not diverting those pills to others that were then overdosing on licit and illicit opium?

A. I am not saying that because I don't think it's more -- I don't have any evidence to say that it's more likely than not that that's where those pills were going. I don't think we have an idea of the fraction that they're going to other people.

Q. But that -- but to be fair, your position is, is that there's something to be said, there is an explanation for why it is that people that are receiving the prescriptions aren't the ones that are dying from the prescriptions?

A. Well, you can't read this graph that way because I seriously doubt that the pills that these people got from

prescriptions in 2001 to 2002 are leading to heroin and fentanyl deaths for people ten years later.

I mean, those pills, they transformed from prescription opioids to heroin and fentanyl and then were ingested by people a decade later, is that what you're saying, because that's what's on this graph?

Q. No, no. No, no. Let's put this graph aside.

I'm asking you, sir, based on your review, do you think that there was a substantial amount of prescription opioids that were diverted in Huntington, Cabell County, West Virginia from the people who originally presented the prescription?

A. My -- I haven't done the study of that, but my understanding is that there were diversions from the pills after those prescriptions were filled and there was also abuse by people who received those prescriptions both.

Q. Thank you.

MR. FARRELL: Judge, may I have a moment?

THE COURT: Yes.

(Pause)

MR. FARRELL: That's all the questions I have, Doctor. Thank you for coming to West Virginia. It was a pleasure to meet you.

THE WITNESS: Thank you so much.

THE COURT: Mr. Hester, do you want to re-direct?

MR. HESTER: Just one -- just one point, Your Honor.

REDIRECT EXAMINATION

BY MR. HESTER:

Q. Dr. Murphy, Mr. Farrell asked you some questions about an assumption that four out of five people who are heroin users began by misusing prescription opioids. Why would that not be sufficient, in your view, to conclude that prescription opioid misuse is a gateway to heroin?

A. Because it simply says a lot of people -- a lot of the people who ended up on heroin previously did something. Let me replace assuming prescription opioids with drinking water. Basically, a hundred percent of the people who initiated on heroin previously drank water. That just -- it doesn't -- that's not looking at the probabilities the right way.

There's also a serious problem with the -- with the theory because let's assume that there are people who move from prescription opioids to heroin and when -- when prescription opioids become less available, but what will happen if you made prescription opioids less available, more people initiate directly on heroin. You might actually end up with more people on heroin, not fewer. That's a problem.

And the plaintiffs' experts in this case don't talk about that at all. And that, in fact, is not a theoretical

possibility, but an actual reality that, as the availability of the prescription opioids have gone down, more people now initiate on heroin. You could actually end up with more people on heroin. And you have to take account of that pathway.

The second thing I would say is the fact that people do A and B doesn't mean there's a gateway or that they move from A to B when one becomes less available.

Give you an example. Think about Coke and Pepsi. What would happen if we reduced the availability of Coke? I mean Coca-Cola, not the other kind of coke. More people would drink Pepsi. People who used to drink Coke will start drinking Pepsi.

That doesn't mean there's a gateway from Coke to Pepsi. It doesn't mean if we didn't have Coke around, there would be fewer people drinking Pepsi. There would be more people drinking Pepsi if we didn't have Coke because they wouldn't be able to drink Coke.

The point is that this evidence that people move from A to B when A becomes less available, in economic terms, that just means there are substitutes. It doesn't tell you it's a gateway.

Q. And so, let me ask a few questions to follow up on that, Dr. Murphy. Is your point that if you simply observe a temporal sequence or a sequence of events, somebody uses

or misuses one drug and then subsequently misuses another drug that you cannot infer a gateway from that temporal sequence of events?

A. Exactly. And you can't because -- for exactly the reasons I talked about. There's several ways that will happen.

One is that you're looking at people who have a propensity to do both. So, often, they'll do A before B.

The second one is they can just -- you know, you can have the kind of situation that I talked about with the Coke and Pepsi.

Q. I want you to build on this point. Are you aware of evidence suggesting that people who misuse or abuse prescription opioids before they abuse heroin also have abused other substances?

A. Yes. That -- the evidence is very clear on that, that many of those who, you know, it was mentioned abused prescription opioids before they used heroin also abused other drugs.

Q. What's the significance of that point?

A. Well, it gets back to economics because, when it gets back to the economics, it's that some people are prone to abuse and they'll abuse prescription opioids if they're available. If they're not available, they'll abuse something else. Or maybe they'll abuse multiple drugs.

And in some of the patterns we observe of people doing multiple things in sequence or at the same time reflect those differences across individuals and you have to take that into account.

Q. In particular, why would it be relevant if people have abused other substances before abusing prescription opioids and before abusing heroin? Why would that be relevant in assessing the gateway?

MR. FARRELL: Objection, Your Honor. I think this goes far afield of the Economic School of Chicago. This is back into epidemiology, as well as the evidence we heard from several other experts.

THE COURT: Overruled.

Go ahead, Mr. Hester.

THE WITNESS: I would say it gets to this -- two things. One is differences across people and the propensity to use drugs of different types. And, also, it gets to this substitute concept, that simply seeing people switch from one to the other or when one becomes less available moves to the other tells us two things.

One is that there are people who have a propensity to do both. And, two, it tells us that one is a substitute for the other. If I can't get one, I'll do the other one, kind of like my Coke and Pepsi example.

Q. And so, is your point that substitutes are not the same

as gateways?

A. No. You can have, in fact, substitutes have -- often have nothing to do with gateways.

MR. HESTER: Thank you, Dr. Murphy. Those are all the questions I have.

THE COURT: Anything else, Mr. Farrell?

MR. FARRELL: Yes, sir.

RECROSS EXAMINATION

BY MR. FARRELL:

Q. Dr. Murphy, you understand that prescription opioids and heroin have the same molecule, same molecular structure? They both -- they both are from the morphine molecule?

A. I understand that; not from my economics training, however.

Q. Yes, sir. So, from an economics standpoint, is it fair to say that prescription opioids and heroin are substitutes for each other?

A. You would -- in economics, you always have to be careful. That would be a factor making me think they would be substitutes. I think we generally look for empirical evidence that they are substitutes because you can come up with examples that look like they would be substitutes and turn out to be complements. I teach a whole lecture on that in my class. I don't want to bore you with that today.

Q. I certainly don't want to get bored with it. So, your

testimony is that heroin and prescription opioids are empirically substitutes?

MR. HESTER: Your Honor, I believe that misstates his testimony.

THE WITNESS: I will clarify it.

THE COURT: Just a minute. Just a minute. Well, I'll let him answer. Go ahead.

MR. FARRELL: It had a question mark at the end.

BY MR. FARRELL:

Q. I'm asking you --

A. You know, I -- I would say if you focus on abuse of prescription opioids and abuse of heroin, they're probably closer to be substitutes. I think heroin is less -- probably not really a substitute for legitimate use of prescription opioids. It's -- you know, people don't substitute much on that margin.

MR. FARRELL: Very good. Thank you.

THE COURT: What's the difference between substitute and a complement? I think I missed that part.

THE WITNESS: A complement are two things that get used together, like tennis ball and tennis rackets. That would be a complement.

And substitute would be like Coke or Pepsi. I like cola. I can drink Coke or I can drink Pepsi.

THE COURT: Okay.

Anything else of Dr. Murphy?

MR. HESTER: No, Your Honor. Thank you.

THE COURT: Dr. Murphy, thank you, sir, very much. I hope you have a good trip out of town and it's been a pleasure having you here. Thank you, sir.

THE WITNESS: Thank you so much, Your Honor.

THE COURT: Yes, ma'am?

MS. MAINIGI: Your Honor, I think there is another witness coming this afternoon, but I just wanted to go ahead and alert the Court, much as I did last week, about where we stand, the defendants in our schedule.

I think that we may -- we're moving quickly and we're skinnying down a little bit. So, I think we may be done as early -- depending on the length of cross examinations, as early as the middle of next week. I've alerted the plaintiffs to that fact.

We're going to be spending some time in the next day or two as a group working through the remainder of our witnesses and I think right now the plaintiffs have notice per our various stipulations of who we are intending to call. Some folks may drop off that list.

What we would propose, Your Honor, is that after we've had a chance to further confer that we speak to the plaintiffs tonight and perhaps come to Your Honor with a proposal for timing of closings and findings of fact,

conclusions of law, and perhaps we could spend some time on that tomorrow.

I do think that since we are moving so quickly and we moved through more quickly than expected on some of the -- these witnesses that we may end up ending a little earlier today. The witness that we have after the next witness can't be here until tomorrow.

I think that might be our only witness tomorrow. So, we may end a little earlier tomorrow, too, which I think would be welcomed by everyone in this courtroom.

And then, we also -- I don't want to forget that we also have depo designations, of course, that we'll continue to work through that we'll submit to the Court next week. So --

THE COURT: Well, that's all welcome news, Ms. Mainigi. You mentioned proposed findings and conclusions. You submitted those a long time ago but, obviously, they'll be --

MS. MAINIGI: Updated.

THE COURT: Updated based on what's happened during the course of the trial, so I can look forward to getting new ones then.

MS. MAINIGI: Ultimately, yes, Your Honor. Yes. Exactly right.

THE COURT: Okay. Well, that all sounds good.

MS. MAINIGI: I thought Your Honor and this Court might appreciate that news.

THE COURT: I'm looking for an appropriate word.

(Laughter)

MS. MAINIGI: Well, that's all I have for today, Your Honor. I think we've got one more witness and, as I said, it's possible that we may not go to the end of today.

THE COURT: Are we ready to go with that other witness or do we need to take a break?

Ms. Wu?

MS. WU: Yes, Your Honor. We'll just get the witness.

THE COURT: Okay. Very good.

COURTROOM DEPUTY CLERK: Sir, please state your name.

THE WITNESS: Peter Boberg.

COURTROOM DEPUTY CLERK: Thank you. Please raise your right hand.

PETER BOBERG, DEFENSE WITNESS, SWORN

COURTROOM DEPUTY CLERK: Thank you. Please take a seat.

THE COURT: Good afternoon, sir.

THE WITNESS: Good morning, Your Honor. Or good afternoon rather.

MS. WU: May we proceed, Your Honor?

THE COURT: Yes, please.

MS. WU: Thank you.

DIRECT EXAMINATION

BY MS. WU:

Q. Doctor Boberg, would you please introduce yourself to the Court?

A. Yes. Good morning. My name is Peter Boberg.

Q. Doctor, how are you currently employed?

A. I'm an economist at Charles River Associates.

Q. What is your understanding of why you're here to testify today?

A. I was asked to look at the flagging analysis of -- performed by Dr. McCann on the ARCOS data and testified to and relied on by Mr. Rafalski.

Q. Now, Doctor, before we go into your qualifications, I want to briefly orient the Court to the opinions that you're going to get into in more detail.

What are the flagging methodologies that you just referenced?

A. Dr. McCann developed six methodologies that he applies to ARCOS shipment data from distributors to pharmacies in Cabell County and Huntington, West Virginia and he applies the algorithms to flag shipments that he believes were caused suspicious or unlawful.

Q. Thank you, Doctor.

MS. WU: Mr. Reynolds, could we please put up Rafalski Demonstrative 223 at Page 14? I'm putting this up. This will refresh us on some testimony which was provided earlier in the case.

BY MS. WU:

Q. Doctor Boberg, are the six methodologies identified in this demonstrative those that you were asked to review in connection with your work in this case?

A. Yes, they are.

Q. What specifically were you asked to review with regard to these methodologies presented by Mr. Rafalski?

A. I was asked to review the methodologies to make sure I understood how Dr. McCann implemented the algorithms and then to assess the reliability and validity of the results he obtained using those algorithms.

Q. Doctor, you just mentioned Dr. McCann, who testified earlier in this trial. Is it your understanding that Dr. McCann did the modeling work that Mr. Rafalski relied on to present these six methodologies to the Court?

A. Yes. That's correct.

Q. What did you conclude about the reliability of these six methodologies presented by Mr. Rafalski?

A. After studying the methodologies, I found the results to be unreliable and invalid. And that was really for three main reasons.

One, I found the results to be lacking in robustness. They're driven almost entirely by a single assumption for which Dr. McCann doesn't provide any basis. And when I remove that assumption, the results essentially go away.

Second, I find that they're inconsistent across the different methodologies. So, running methodologies that ostensibly do the same thing, they achieve very different results and that suggests they're unreliable.

And, third, I looked at the results and compared them to other evidence. In particular, I looked at the DEA's estimates of the actual rate of diversion out of the controlled channel and found Dr. McCann's estimates were very, very different than the DEA's estimates and so, concluded that his results were unreliable.

Q. Okay. So, I want to unpack those just very briefly for the Court's benefit. You mentioned assumptions. How do the assumptions used in these models relate to your opinion about the reliability or lack thereof of these methodologies?

A. Well, as I said, the assumptions that Dr. McCann makes, he assumes that after a shipment is flagged every subsequent shipment must also be flagged and he really provides no basis for that. He didn't investigate whether that assumption was valid or true and, yet, it drives almost all of his results. And so, I find that makes his results

unreliable.

Q. You also mentioned that these six results presented by Mr. Rafalski have inconsistent results. How does the inconsistency in those results impact your determination that the methodologies are unreliable?

A. Well, when I find that Dr. McCann's results as flagging 72 percent of shipments as unlawful using Method A, but only 28 percent, for example, using Method B, you know, both numbers can't be right. Both sets of flagged shipments can't -- you know, it can't be correct.

Dr. McCann provides no guidance about which one is correct or a framework with which to evaluate which one is correct. And so, that -- really, that inconsistency means the results are unreliable.

Q. Now, the last critique that you offered in brief is that the results of Mr. Rafalski's six methodologies are unrelated to real world information. Can you explain that for the Court?

A. Yes. I saw that Dr. McCann was flagging a very large percentage of shipments into Huntington and Cabell County as unlawful and suspicious and I wanted to know, you know, is that -- is there some evidence that helps us understand whether that's a reliable estimate.

And the DEA does determine the level of diversion out of the controlled channel as part of its obligations. And

that level is very, very low. It's about .1 percent in the case of oxy and hydro and that just doesn't compare with what Dr. McCann's findings -- his -- his flagging is far in excess of that. And so, I find that's unreliable.

Q. Thank you, Doctor.

MS. WU: Mr. Reynolds, we can take down the demonstrative.

BY MS. WU:

Q. Dr. Boberg, were you also asked to perform some analyses that are specific to McKesson?

A. Yes, I was.

Q. And what analyses were you asked to perform?

A. I was asked to look at McKesson's market share in Huntington and Cabell County and look at Dr. McCann's calculation of that market share.

Q. Thank you, Doctor. So, now that we've provided an overview of your opinions in this case, let's talk about your qualifications.

How would you describe the expertise that you bring to the work that you have done for this case?

A. Well, most of my work involves applying economics and econometrics in the principles of data analysis to various settings. So, sometimes that's in litigation cases in courts like this one. Most often, it's before regulators like the Federal Trade Commission or the Department of

Justice.

Q. Doctor, how did you become an expert in econometrics and data analysis?

A. I received my Ph.D. in Economics from the University of Michigan. Prior to that, a Bachelor's in Economics from the University of Alberta in Canada. And then, after my Ph.D., I joined Charles River Associates, where I've been for the last 21 years.

Q. What is Charles River Associates, or CRA, as sometimes we refer to it?

A. It's an economic consulting firm based in Boston.

Q. What type of work and analysis have you undertaken during your career as an economist at CRA?

A. Well, I've worked on cases in a lot of different areas, a lot of different industries, a lot of different types of matters.

I do have quite a bit of experience looking at the pharmaceutical industry. I've looked at matters involving pharmaceutical manufacturing, pharmaceutical distribution, pharmacy benefit management, retail pharmacy. So, I do have experience analyzing large datasets in that type of context.

Q. Doctor, can you give the Court some examples of the type of data analytics that you've undertaken in the course of your career?

A. Sure. An example would be for a merger of large

national retail chain pharmacies. I was retained by the Federal Trade Commission to assist them in their antitrust evaluation of that transaction. In that context, I analyzed terabytes of prescription data from thousands of pharmacies on thousands of drugs for multiple years. So, that's the type of data analytics I get involved in.

Q. Doctor, is it common for you to be called upon to review the models or analyses put forward by other experts and economists?

A. Yes, it is.

Q. Doctor, during the course of your career, have you published articles in the fields of econometrics and modeling?

A. Yes, I have.

Q. And have you also lectured or been asked to give presentations in those same areas?

A. Yes, I have.

Q. Based on your expertise in economics and data analysis, have you been asked to serve as an expert in litigation previously?

A. Yes. Occasionally, yes.

Q. Have you ever testified at trial in any of those matters?

A. Yes, once.

Q. Is your work in the litigation context a significant

portion of the work that you do at CRA?

A. No. Most of my work is not -- not in litigation.

Q. Thank you, Doctor.

MS. WU: Your Honor, I'd tender Dr. Boberg as an expert qualified in econometrics and the analysis of large datasets.

THE COURT: Any -- any objection?

MR. FARRELL: Judge, may I voir dire the witness?

THE COURT: Pardon me?

MR. FARRELL: May I voir dire the witness?

THE COURT: Yes, you may.

CROSS EXAMINATION

BY MR. FARRELL:

Q. Dr. Boberg, I introduced myself briefly. My name is Paul Farrell. I have a couple of questions for you. Have you ever designed or implemented a Suspicious Order Monitoring System for anybody in the pharmaceutical industry dealing with controlled substances?

A. I have not.

Q. Are you familiar with or an expert in the field of tracking pharmaceuticals within the closed chain of distribution?

A. I'm not an expert on that.

Q. All right. And I was a little confused, but do you intend to offer opinions on whether the criteria that form

the basis of Dr. McCann's algorithms are appropriate?

A. No. I was asked to look at Dr. McCann's application of the algorithms, not the underlying algorithms.

Q. That's what I was getting to. You're going to simply take for truth the six methodologies that were just shown to you and advise the Court whether or not those six methodologies were appropriately inputted by Dr. McCann with the data; is that my understanding?

A. I have been asked to look at how Dr. McCann applied the algorithm. So, I'm looking at his application of the algorithms. And that includes assumptions that he made to implement the algorithms, choices he made along the way, and the results that he obtained as a result of his application.

Q. Well, your expert report says on Paragraph 62, I offer no opinion on whether the criteria that form the basis for Dr. McCann's algorithms, with or without Dr. McCann's assumption about flagging all reported transactions thereafter, are appropriate for flagging shipments.

Are you -- are you intending to testify today that you do have comments upon Dr. McCann's assumptions?

A. What I'm saying in that paragraph is that I'm not offering an opinion as to whether a particular methodology, if it were used by a distributor, for example, is appropriate or not. That's not something I have expertise on. I'm simply looking at Dr. McCann's application of the

algorithm and how he obtained his results in assessing whether that application is reliable.

MR. FARRELL: Okay, thank you.

THE COURT: Do you object to his -- me finding him as an expert, Mr. Farrell?

MR. FARRELL: I don't think so, Judge.

THE COURT: The Court finds Dr. Boberg to be a qualified expert witness in the fields of -- I will have to look in my notes here.

I can't read my writing, Ms. Wu. You will have to tell me again.

MS. WU: Your Honor, we tender Dr. Boberg as an expert witness qualified in the fields of econometrics and the analysis of large datasets.

THE COURT: All right. I find Dr. Boberg to be a qualified witness expert in the fields of econometrics, data analysis and large datasets.

Did that get it?

MS. WU: Yes, Your Honor. Thank you.

May we proceed?

THE COURT: You may proceed.

MS. WU: Thank you.

BY MS. WU:

Q. Doctor, before we talk about those analyses, Dr. McCann's application of the methodologies that you just

discussed, I would like to talk about the dataset that Dr. McCann started with. Did you review Dr. McCann's trial testimony concerning the dataset that he used to complete his work in this case?

A. Yes, I did.

Q. What is your understanding of the nature of the dataset that Dr. McCann employed?

A. Dr. McCann built a dataset that consists of pharmaceutical shipments from distributors to pharmacies in Huntington and Cabell County using ARCOS data, which is data from the DEA, as well as supplements that were data from the defendant distributors, Cardinal, McKesson and ABDC.

Q. Doctor, do you have an understanding of why Dr. McCann supplemented the ARCOS data with transactional data from the distributor defendants in this case?

A. Yes. The ARCOS data Dr. McCann has is limited to the time frame 2006 to 2014. So, he uses the distributor data to fill in areas outside of that and, as well, he has some gaps in the ARCOS data. And so, he uses the defendant distributor data to augment or supplement and correct in the cases the ARCOS data.

Q. Doctor, in connection with your work in this case, did you spend time reviewing Dr. McCann's dataset?

A. Yes, I did.

Q. And what did your review of Dr. McCann's dataset

involve?

A. I looked at the underlying code that Dr. McCann provided that he wrote to build his dataset and looked at the data itself.

Q. Did you review Dr. McCann's dataset for accuracy?

A. No, I -- I did not review it for accuracy. I was asked to evaluate the reliability of Dr. McCann's application of the algorithms. I wanted to use the same data as Dr. McCann. And so, I just wanted to understand how he put that data together, but I didn't look -- I didn't assess whether the data themselves are reliable.

Q. Do you have an opinion on whether Dr. McCann's data itself is reliable?

A. No, I do not.

Q. So, I'd like to continue with this dataset as assembled by Dr. McCann. Does that dataset include the information for all orders received by the distributor defendants in this case?

A. No, it does not. So, as I said earlier, it's shipment data, so it does not include all orders.

Q. Why is it that a dataset which includes shipments only might differ from a dataset that would include all orders?

A. Well, there are a few reasons that orders might not turn into shipments. So, one is that the distributors may be conducting due diligence and blocking orders, in which

case they would not turn into shipments.

It could also be the case that orders are received and drugs are unavailable, out of stock, and so, there's no shipment that occurs. Or it could be that orders come in and there's financial issues that -- that prevent the order from turning into a shipment.

Q. So, there are various reasons that the data for shipments and orders may differ significantly?

A. Yes, that's correct.

Q. Doctor, based on your review of evidence in this case, are you aware that the distributor defendants, McKesson, ABDC and Cardinal, in fact, operated regulatory programs that did block orders for prescription opioids?

MR. FARRELL: Objection, Your Honor. I think this is outside the scope of his expertise and is cumulative with the testimony directly from the defendants. I don't think this witness has been qualified to be offering opinions about the SOMS system McKesson used.

MS. WU: Your Honor, the witness is providing his input based on review of evidence in order to explain the nature of the dataset that Dr. McCann presented and not to opine on the nature of the programs operated by the defendants.

THE COURT: Overruled.

You may proceed.

MS. WU: Okay.

BY MS. WU:

Q. Doctor, do you need the question again?

A. Sure.

Q. Okay. Based on the evidence that you reviewed in this case, are you aware that the defendants, ABDC, McKesson and Cardinal, did, in fact, operate programs that blocked certain orders for prescription opioids?

A. Yes. I reviewed a file of blocked orders from McKesson, for instance.

Q. Are those blocked orders reflected in the McKesson data that you reviewed for purposes of this case reflected in the -- in the shipment data that McCann used, Dr. McCann used, to present his work in this case?

A. No. Those blocked orders would be examples of the kind of orders that we talked about that don't end up in the shipment data that Dr. McCann analyzed.

Q. Dr. Boberg, in your opinion, why does it matter that Dr. McCann used data which is limited to shipments in order to try to identify suspicious orders?

A. Well, it really means he's running --

MR. FARRELL: Objection, Your Honor. Again, if this is application to algorithms to data, that's one thing. If this is talking about the legal requirements of identifying suspicious orders, that's something completely

different, Judge.

MS. WU: Your Honor, the witness is talking about providing testimony as to the appropriateness of the data that Dr. McCann used, not as to the nature of the programs.

THE COURT: I think this is an appropriate basis for what I expect his expert opinion to be. I will overrule the objection and let you go ahead.

MS. WU: Thank you, Judge.

THE WITNESS: So, the dataset that he relies on is not the right dataset to run the algorithms on for purposes of flagging orders because of shipments and if, you know, orders are not in the data, the orders that are not in the data are likely to be the ones that the algorithms would be trying to flag and that's going to make the algorithms flag the wrong shipments.

BY MS. WU:

Q. Thank you, Doctor. So, now I want to turn to some of those methodologies which Mr. Rafalski presented to the Court. As an initial matter, have you reviewed Mr. Rafalski's trial testimony from this case?

A. Yes, I have.

Q. And you testified a few moments ago that Mr. Rafalski relied on the work of Dr. McCann in order to run methodologies for flagging purposes, correct?

A. Yes, that's correct.

Q. Did you review Dr. McCann's trial testimony about those flagging methodologies?

A. Yes, I did.

Q. And did you also review his work papers and deposition in this case?

A. Yes. Dr. McCann testified in his deposition about -- about the methodologies and I reviewed that, as well as his report and backup materials.

Q. Based on your review of Dr. McCann's work, were you able to understand how Dr. McCann's six flagging methodologies operate?

A. Yes. I was able to essentially write my own code that replicated what Dr. McCann did based on his descriptions and backup materials. And so, I was able to satisfy myself that I understood Dr. McCann's analysis.

MS. WU: Mr. Reynolds, could we put back up on the screen Rafalski Demonstrative 223 at Page 14?

BY MS. WU:

Q. Dr. Boberg, once again, these are the six methodologies, the flagging methodologies that Mr. Rafalski presented to the Court, correct?

A. Yes, that's correct.

Q. Based on your review of Mr. Rafalski's trial testimony on this case, in this case, do you have an understanding that Mr. Rafalski believes certain of these flagging

methodologies are unreliable?

A. Yes. I believe Mr. Rafalski testified that he relies on Methods A and B, but views Methods C, D, E and F as unreliable.

Q. Okay. So, based on Mr. Rafalski's testimony, we'll drop Methods C, D, E and F from our list and we'll focus our work this afternoon on Methods A and B. So, let's do that now.

So, Method A, as described by Mr. Rafalski to this Court, is the maximum monthly trailing six-month thresholds. Do you see that, Dr. Boberg?

A. Yes, I do.

Q. Okay.

MS. WU: Now, to help us talk about this Method A, Mr. Reynolds, could we please put up McKesson Demo 2 at Page 1?

BY MS. WU:

Q. Dr. Boberg, is this demonstrative a presentation of how Dr. McCann's Methodology A operates?

A. Yes, it is.

Q. Using this demonstrative, could you describe for the Court your understanding of how Dr. McCann's Method A functions to flag orders?

A. Yes. So, this demonstrative provides sort of a made-up dataset of shipments from a distributor to a pharmacy of a

particular drug and the numbers represent dosage units shipped in the month.

What Dr. McCann's Method A algorithm does is it looks at the first six months. That's January, February, March, April, May, June and finds the maximum across those six months, which is the 10,000 dosage units shipped in February.

It then uses that maximum, the 10,000, as a threshold and tests whether the shipment volume in the seventh month, July, exceeds that threshold or not.

In this case, it does not. It's only 4,900. So, July is not flagged.

Then the algorithm proceeds to the next month, August, which shows the dosage unit volume of 10,100. That does exceed the threshold from the prior, the maximum from the prior six months, the 10,000. And so, August gets flagged and we've turned that red in the demonstrative.

Q. Now, from that point on, I see that the balance of the orders in this demonstrative are also flagged red. Are they flagged because Method A flags orders that exceed the threshold or for some other reason?

A. For other reasons. So, Dr. McCann's algorithm after August would no longer flag, for instance, September because September's volume is only 7,000. So, it's below the threshold, which is the maximum from the prior six months.

But Dr. McCann, instead of simply applying the algorithm, he adds this additional assumption that once he flags a shipment from a distributor to a pharmacy of a particular drug, he assumes that every subsequent shipment should also be flagged, viewed as suspicious and unlawful. So, he turns the entire set of shipments red.

Q. And just for clarity based on some questions you received from Mr. Farrell, is that assumption separate from the underlying algorithm that Dr. McCann utilized for Method A?

A. Yes. It's a separate assumption, that's correct.

Q. Dr. Boberg, what would happen to Method A if you removed that automatic flagging assumption as employed by Dr. McCann?

A. What would happen is you'd no longer flag the vast majority of the shipments. You would only flag those shipments in August.

Q. And we've now gone to the second page of McKesson Demonstrative 2. How does this second page of the demonstrative illustrate the impact of removing that assumption?

A. Well, as we've just said, and indicated, and shown on the screen, it's a pretty dramatic effect in this example. We'll see it's a dramatic effect in Dr. McCann's actual results, as well, but it means that he is really excessively

flagging shipments by using -- applying this assumption. And when we take the assumption away, Dr. McCann's algorithm flag very few shipments.

Q. Thank you, Doctor.

MS. WU: Mr. Reynolds, we can take down the demonstrative.

BY MS. WU:

Q. Dr. Boberg, based on your review of the record in this case, including testimony from Dr. McCann and Mr. Rafalski, do you have an understanding of why they implemented this automatic flagging assumption?

A. Well, Dr. McCann really doesn't provide a basis, as far as I understand he was asked to apply the assumption by counsel.

Mr. Rafalski says that the assumption is reflective of the idea that there was no due diligence done on the first order and, therefore, every subsequent shipment should be blocked and regarded as suspicious and unlawful.

So, I think Dr. McCann provides no basis. Mr. Rafalski explains the assumption.

Q. Dr. Boberg, based on your review of record evidence in this case, are you aware of any evidence which is contrary to that assumption as employed by Dr. McCann?

A. Yes. As we were just speaking about a bit ago, I reviewed, for instance, blocked order reports from McKesson

that showed due diligence was being done and orders were being blocked. So, that type -- that shows that the assumption that Dr. McCann has made is really not valid.

Q. Dr. Boberg, in your opinion, does Dr. McCann's decision to automatically flag subsequent orders using this assumption affect the validity and reliability of his Method A?

A. Yes. As we will see, it really impacts the robustness of the analysis. When we take that assumption away, his results really go away.

Q. Dr. Boberg, did you prepare some charts in connection with your work in this case and the report that you prepared which help illustrate the power of that assumption in Dr. McCann's work?

A. Yes, I did.

MS. WU: Mr. Reynolds, could we please put up Boberg Demonstrative number 3, please?

BY MS. WU:

Q. Dr. Boberg, are these the charts from your report which set forth your presentation of the automatic flagging methods?

A. Yes, they are.

Q. Dr. Boberg, can you use these charts to explain for the Court what is represented on the left-hand side in terms of presentation of Dr. McCann's implementation of Method A with

the automatic flagging assumption?

A. Yes. On the left-hand side I've provided a visual depiction of Dr. McCann's results. So, the -- the picture shows the results of Dr. McCann's Method A applied to ARCOS data shipments from all distributors, or from the three defendant distributors into Huntington and Cabell County, West Virginia.

The height of the bars, each bar, represents the monthly shipment volume for that month. And then, I've colored the bar dependent on whether Dr. McCann's algorithm is flagging shipments or not. So, the fraction of the bar that's colored red is the fraction of shipments that Dr. McCann is flagging with his application of the algorithm. And I've colored blue the portion that represents the fraction that he's not flagging.

Q. Dr. Boberg, what proportion of shipments did Dr. McCann flag as suspicious using his Method A with the automatic flagging assumption turned on?

A. So, with the assumption he's flagging about 72 percent, 71.9 percent of shipments.

Q. Doctor, is there a way to determine the amount of shipments that were automatically flagged by Dr. McCann based on the automatic flagging assumption, as opposed to the algorithm?

A. Yes. So, what I was able to do is take Dr. McCann's

code and essentially turn off -- you know, there's a line in the code that imposes the assumption and I can turn that piece of code off and re-run his algorithm so that it's the same analysis. I'm just taking out the assumption.

Q. And did you, in fact, re-run the algorithm for Method A with the automatic flagging assumption turned off?

A. Yes, I did.

Q. Are the results of that analysis presented in the right-hand chart on the screen?

A. Yes, that's correct.

Q. Dr. Boberg, could you describe for the Court, using your chart, the results of removing the automatic flagging assumption from Dr. McCann's Method A?

A. Sure. So, on the right-hand side, I provided the visual depiction analysis as on the left but, again, removing that assumption. And you can see that almost all the bars turn blue, or almost entirely blue, and Dr. McCann's analysis, once we turn off that single assumption, flags only 3 percent, about 3 percent, 3.1 percent of shipments.

Q. Dr. Boberg, based on the work that you've done and these two charts depicting it, are you able to calculate the percentage of shipments flagged by Dr. McCann's Method A that were flagged only due to the automatic flagging assumption?

A. Yes. That would be 96 percent. So, 96 percent of the red bars on the left are due solely to the assumption for which Dr. McCann provided no basis.

Q. And just to clarify, that almost 96 percent of shipments flagged by Dr. McCann's Method A were for shipments that did not exceed the thresholds that he had set under Method A, correct?

A. That's correct.

Q. Doctor, in your opinion, is Dr. McCann's Method A a valid and reliable approach for flagging suspicious orders?

A. No. Given the lack of robustness, when you take one assumption away, I would say they're not reliable.

Q. Thank you, Doctor.

MS. WU: Mr. Reynolds, could we put back up on the screen Rafalski Demonstrative 213 at Page 14?

BY MS. WU:

Q. So, all we have left now is Method B. And, Doctor, Mr. Rafalski referred to Method B as the trailing six-month maximum monthly fixed after first triggered threshold. Do you see that, Doctor?

A. Yes. It's a mouthful. I do see that.

Q. Sure is. Okay. Doctor, can you describe to the Court how Method B, presented by Mr. Rafalski based on Dr. McCann's underlying work, operates?

A. Yes. Method B is almost the same as Method A. It

starts out the same way, looks at the six -- prior six months to establish the maximum as the threshold, but whereas Method A says once I flag a shipment, I will assume that every subsequent shipment has to be flagged, Method B uses a different assumption. It doesn't make that assumption but, instead, assumes that the threshold needs to be fixed forever.

So, once -- once Dr. McCann sees a flag, then he freezes the threshold and uses that same threshold for the rest of -- of the period.

Q. Dr. Boberg, what is the impact of fixing the threshold under Method B?

A. It's quite similar to what happens when he uses the assumption in Method A. It essentially ensures that there can be no legitimate increase in volume of shipments into Huntington or Cabell County. It would -- any legitimate increase in shipments would be flagged as unlawful and suspicious by the assumption.

Q. Dr. Boberg, did you prepare some charts that would help you describe the impact of the fixed threshold on Method B?

A. Yes, I did.

Q. Mr. Reynolds, could we please put up Boberg Demonstrative number 4?

Doctor, are these the charts that you prepared in order to illustrate the impact of Dr. McCann's fixed threshold

assumption on Method B?

A. Yes, they are.

Q. Doctor, starting with the left-hand chart, could you describe for the Court the impact of the fixed threshold assumption as run by Dr. McCann?

A. Yes. The left-hand side presents a visual depiction of the results of Dr. McCann's Method B, again, applied to the ARCOS data for shipments into Huntington and Cabell County.

And this time, with the assumption that the threshold should be fixed, Dr. McCann's algorithm is flagging about 28 percent of shipments, 27.6 percent.

Q. So, that's about 28 percent of shipments with that fixed threshold assumption turned on, correct?

A. That's correct.

Q. Dr. Boberg, what happens when you apply Method B, re-run the model, removing that fixed threshold assumption?

A. So, I've shown that on the right-hand side with the chart on the right-hand side and that reduces the flagging to about 3 percent rather than the 28 percent that Dr. McCann flagged.

Q. Dr. Boberg, are you able to calculate, based on your work in this case as presented by these charts, what percentage of shipments flagged by Dr. McCann's Method B were flagged due to the application of the fixed threshold assumption?

A. That's about 89 percent. So, 89 percent of the red bars on the left are really due solely to that assumption that the threshold should be fixed.

Q. So, they were flagged due to the assumption, as opposed to the underlying algorithm associated with Method B, correct?

A. That's correct.

Q. Doctor, in your opinion, is Method B with the fixed threshold assumption turned on a valid and reliable method for identifying suspicious orders?

A. Well, again, just from the perspective of data analysis, when the results of an analysis hinge so critically on an assumption, there's no support for the assumption. That means the results are really not reliable.

Q. Thank you, Doctor. So, you also flagged that Dr. McCann's results are inconsistent in terms of the results that they've produced and I'd like to turn to that opinion.

Have you prepared a demonstrative that would help you explain the inconsistency in the results presented by Dr. McCann's Methods A and B?

A. Yes, I have.

MS. WU: Mr. Reynolds, could we please put up Boberg Demonstrative number 6, please?

BY MS. WU:

Q. Dr. Boberg, is this your demonstrative presenting the

difference in results under Dr. McCann's Method A and B with his assumptions turned on?

A. Yes.

Q. Can you explain the difference in results presented in these charts?

A. Yes. So, on the left under Method A with his assumption that every subsequent shipment should be flagged, Dr. McCann flagged about 72 percent of shipments. On the right, using Method B, which is supposedly also flagging the shipments that should be regarded as suspicious and unlawful, Dr. McCann, with his alternative threshold -- fixed threshold assumption, is flagging 28 percent of shipments.

Q. Dr. Boberg, does this inconsistency impact the reliability of Dr. McCann's analyses?

A. Yes. When -- again, sort of from the perspective of analyzing data, when you have two methods that are supposed to be doing the same thing and they get such dramatically different results, that's a sign of inconsistency.

Dr. McCann doesn't do anything to explain why these methods are getting different answers and doesn't provide any guidance or framework for figuring out which of them might be correct, if any, and that, from the perspective of data analytics, says that they're really not reliable.

Q. Thank you, Doctor.

MS. WU: Mr. Reynolds, we can take down the demonstrative.

BY MS. WU:

Q. Dr. Boberg, at the outset of your testimony, you also offered the opinion that data analysts are supposed to check their results. They're supposed to take the results and check them against real world data; do you recall that?

A. Yes, I do.

Q. Why is it important for a data analyst to check results against real world information?

A. Well, one of the things that often happens when you run data analysis is there's, you know, questions about, you know, you can often get numbers to say a lot of different things depending on how you analyze them and how you present them. And so, it's really important when you look at the results of the data analysis to see if they're corroborated by other types of evidence.

So, that might be documentary evidence, or testimony, or scientific studies, or, you know, in this case, information from regulators, but it is important to make sure that the results you're getting are verified or validated by other sources.

Q. Is it generally accepted in your field of economics and data analysis to conduct those types of real world data checks?

A. Yes.

Q. Based on your review of the record in this case, do you know if Dr. McCann undertook any type of check of his data results against real world information?

A. No, he did not. He ran the algorithms and reported the results, but he didn't do anything to test them or check their validity or reliability.

Q. Dr. Boberg, did you, yourself, undertake the exercise of checking Dr. McCann's results against real world information?

A. Yes.

Q. What exercise did you undertake?

A. Well, given the large percentage of shipments that Dr. McCann flagged as suspicious and unlawful, I looked for a source of information that might be informative as to what the actual amount of diversion is out of the controlled channel and I found the DEA does -- you know, has an obligation to estimate that number each year and they made those estimates public in 2018 and in 2019. So, I compared Dr. McCann's flagging of shipments against the DEA's estimate of the actual diversion out of the controlled channel as kind of a check.

Q. And the data analysis that you've conducted outside of this case and other opioid litigation, is it common for you to look at a government regulator as a source of information

to conduct a data check?

A. Yes. So, for example, we might turn to the CMS, the Center for Medicare/Medicaid Studies, to get data in the case of hospital or pharmaceutical matters that involve Medicare, for example. So, here, I turned to the DEA as the regulator for this particular area.

Q. Doctor, have you prepared a demonstrative that would help you explain the data check that you conducted comparing Dr. McCann's results to DEA information?

A. Yes, I did.

MS. WU: Mr. Reynolds, could we please put up Boberg Demonstrative number 7?

BY MS. WU:

Q. Dr. Boberg, is this the demonstrative chart, actually, that you prepared in connection with your work in this case?

A. Yes, it is.

Q. Could you describe --

MR. FARRELL: Objection, Your Honor. I don't think the foundation has been laid for what the DEA said was the percentage of diversion that occurred and if the DEA did say such a thing, it would be hearsay, and I don't believe that the foundation has been laid to establish this opinion.

MS. WU: Your Honor, certainly, Dr. Boberg may rely on hearsay evidence. He has been qualified as an expert. I believe that Mr. Farrell's concerns will be

addressed as we walk through Dr. McCann's explanation of this chart, if you provide us a little bit of leeway.

THE COURT: Yeah. I think this goes to the weight rather than the admissibility of the opinion and the rules are clear that he can rely on the evidence that's not admissible if it forms a legitimate basis for his opinion.

Mr. Farrell, do you want to say anything else?

MR. FARRELL: I do, Judge. I would like to know what the evidence is he's relying on.

THE COURT: Well --

MS. WU: Your Honor, we will talk through the actual data source and, also, Mr. Farrell is free to cross examine the witness using his reliance materials.

THE COURT: Yes. Overruled.

Go ahead, please.

MS. WU: Thank you, Your Honor.

BY MS. WU:

Q. Dr. Boberg, how did you identify DEA reporting as a real world check for Dr. McCann's data analysis?

A. Well, the DEA has the obligation to estimate the diversion out of the controlled channel and it does that each year. So, I looked on the DEA's website and found their estimates of diversion out of the controlled channel.

THE COURT: What's wrong with that, Mr. Farrell?

MR. FARRELL: Nothing, Your Honor. I'll sit down.

THE COURT: You can cross examine him on it, but he's just explaining what he relied on as a basis of his opinion and if you can bring out that it's not a valid basis on cross, then -- then we'll go from there.

BY MS. WU:

Q. Doctor Boberg, based on your review of the publicly available estimates from DEA, what percentage of hydrocodone and oxycodone did DEA estimate was diverted from the closed system for the year 2018?

A. That's about .1 percent.

Q. And has the DEA published similar estimates for the year 2019?

A. Yes.

Q. Now, having laid that foundation for the DEA information that you utilized for your work, could you explain to the Court the data comparison that you conducted comparing Dr. McCann's Method A results from DEA estimates of diversion from the closed system?

A. Yes. So, on the left-hand side, I've shown -- provided a visual depiction of the percentage of shipments in effect that the DEA says were diverted. So, this is -- I calculate this as the DEA's estimate of diversion out of the controlled channel divided by total shipments in the U. S. and that gives me a percentage.

And across the various opioids and, as we said for oxy

and hydro, that percentage is about .1 percent. It's less than a quarter of a percent across all the drugs that I had data for.

On the right-hand side, I've compared that with the results of Dr. McCann's application of the Method A algorithm to shipments into Cabell County and Huntington, West Virginia, where he's flagging 72 percent of shipments as unlawful and suspicious and likely connected to diversion out of the controlled channel.

Q. Dr. Boberg, from your perspective as a data analyst, how are DEA's estimates relevant to your evaluation of Dr. McCann's analysis?

A. Well, if Dr. McCann is flagging such a large share of shipments, one would expect that the DEA would be estimating a fairly large amount of diversion out of the controlled channel. That's not what I see.

So, I find that Dr. McCann is flagging far in excess of any number that would be consistent with the estimates of actual diversion out of the controlled channel by the DEA.

Q. Thank you, Doctor.

MS. WU: Mr. Reynolds, we can take down the demonstrative.

BY MS. WU:

Q. Now, I would like to turn to the last area that you had introduced to the Court, which is McKesson's market share.

You testified earlier that you were asked to analyze McKesson's market share as it relates to the distribution of prescription opioids in Cabell County, correct?

A. Yes, that's correct.

Q. What materials do you rely on in order to conduct that analysis?

A. I relied on the ARCOS data as prepared by Dr. McCann.

Q. And so, that's the ARCOS data as supplemented with transactional data from McKesson, correct?

A. That's correct.

Q. Doctor, have you prepared a demonstrative to assist you in explaining your analysis of McKesson's market share to the Court?

A. I have.

MS. WU: Mr. Reynolds, could we please put up Boberg Demonstrative number 9? Thank you.

BY MS. WU:

Q. Doctor, is this the demonstrative that you prepared to assist with the presentation of your analysis of McKesson's market share?

A. Yes, it is.

Q. Dr. Boberg, are you aware that McKesson ships prescription opioids to the VA Medical Center in Huntington, West Virginia?

A. Yes, I am.

Q. Based on your review of Dr. McCann's flagging methodologies in this case, are you aware of whether or not Dr. McCann applied those flagging methodologies to shipments of prescription opioids that McKesson made to the VA Hospital?

A. No. Dr. McCann applied his algorithms to shipments to chain and independent pharmacies only. He did not include the VA Hospital.

Q. Doctor, did you undertake to calculate the percentage of McKesson's distribution of oxycodone and hydrocodone to Cabell County for the years 2006 to 2014 that went to the VA Medical Center?

A. Yes.

Q. And what percentage did you calculate?

A. That's up on the chart. It's 76, about 76 percent, 76.1.

Q. Dr. Boberg, were you able to determine what Dr. McCann's market share in Huntington and Cabell County would be as compared to other distributors if you removed the VA from McKesson's shipments of hydrocodone and oxycodone?

A. Yes.

Q. What percentage did you calculate?

A. I calculated about 6 percent. And that's the same number that Dr. McCann calculates using the same data.

MS. WU: Thank you, Doctor. I have no further

questions at this time.

THE COURT: All right. Let's take a break here and then we'll come back and subject you to cross examination, Dr. Boberg.

THE WITNESS: Thank you.

(Recess taken)

(Proceedings resumed at 3:27 p.m. as follows:)

THE COURT: You can resume the witness stand, sir.

Go ahead, Mr. Farrell.

CROSS EXAMINATION

BY MR. FARRELL:

Q. Good afternoon. I'm Paul Farrell. We met off the record. I have a few questions for you.

MR. FARRELL: Can we bring up the first slide with the methodologies?

Judge, may I?

THE COURT: Yes, please.

BY MR. FARRELL:

Q. Dr. Boberg, you understand that these six methodologies were presented to this Court through former DEA Agent James Rafalski?

A. Yes.

Q. And you understand that Methodology A came from a literal interpretation of the *Masters* vs. *Pharmaceutical*

case published by the Circuit Court in the District of Columbia?

A. I, I'm not familiar with --

Q. You weren't aware of that?

A. I'm generally familiar with the connections of the -- a connection being drawn to *Masters* but, you know, I'm not an expert on *Masters*.

Q. And you understand that Mr. Rafalski was actually the investigator from the DEA on the *Masters* case?

A. I understand that from his, his trial transcript.

Q. And then subsequent to that, you understand that B comes from using not the *Masters* language from the Circuit Court of the District of Columbia. B is actually using the policy manual from *Masters Pharmaceutical*.

Did you understand that?

A. Well, let me just clarify. I mean, Method A and Method B, as Dr. McCann applies them, has these assumptions in them. And as I understand it, those are not part of *Masters* or, or other sources.

Q. That's not my question. My question is do you understand that the testimony from this case from Mr. Rafalski was that A and B come from *Masters Pharmaceutical* distributor?

A. A and B, as Dr. McCann ran them or, I mean -- as he ran them, no, because Dr. McCann runs them on shipment data

rather than orders. And he's invoking assumptions that, as I understand it, are not part of the methodology.

Q. Okay. Sir, you understand that the DEA has testified in this case through their 30(b)(6) witness on what to do with all future orders? Do you understand that's in the record?

MS. WU: Your Honor, objection, foundation. This isn't the proper witness to cross with DEA testimony he's never reviewed.

THE COURT: Well, this is cross-examination. Go ahead, Mr. Farrell. I think wide latitude should be permitted here. Go ahead.

BY MR. FARRELL:

Q. Were you aware that the DEA itself has validated the concept of once you block a suspicious order, you should block all future shipments until cleared?

A. That's not something I'm aware of from reviewing testimony.

THE COURT: Mr. Mahady.

MR. MAHADY: Your Honor, I would just note that we do object on foundation grounds to that question and statement. And I think Mr. Prevoznik's deposition testimony and what's been designated by both sides speaks for itself. But that's just for the record.

THE COURT: Well, overruled.

Go ahead, Mr. Farrell.

BY MR. FARRELL:

Q. Let me put it in a different context. You understand that some of the defendants themselves, like AmerisourceBergen, had policies in effect that said that once an order is blocked, all future shipments of the same base code should also be blocked until cleared of due diligence?

A. So, again, that -- what I was asked to look at is Dr. McCann's application of these algorithms, so I'm not familiar with what the defendant distributors' policies were.

Q. And you understand that Methodology E comes directly from McKesson, the distributor that hired you in this case?

A. I, I don't think that's -- I don't think that's a correct way to say that. No, I don't agree.

Q. Well, let me say it in a different way. Have you read the deposition of Nate Hartle who is the 30(b)(6) deponent for McKesson?

A. I have not.

Q. Okay. Are you aware that he testified about this 8,000 dosage unit limit rule? It's in his testimony.

A. Again, as -- what I look at is Dr. McCann's application of these algorithms. So I did not review that testimony.

Q. Sir, I'm asking you whether or not you have looked at

the deposition of Nate Hartle and understand that Methodology E is McKesson's methodology.

A. I have not reviewed the testimony.

Q. Have you applied Methodology E to the data?

MS. WU: Your Honor, foundation. I don't believe that Mr. Farrell has a good faith basis to continue this line of questioning when the witness has said that he has not reviewed these materials.

MR. FARRELL: Judge, my good faith basis -- I'm sorry.

THE COURT: Well, the fact that he hasn't reviewed them is part of the point you're making, isn't it?

MR. FARRELL: Yes.

THE COURT: Okay. Overruled. Go ahead.

BY MR. FARRELL:

Q. In fact, have you actually tried to apply McKesson's own algorithm to McKesson's data to see how many orders should have been flagged?

A. That's not what I was asked to do. No, I have not. I looked at Dr. McCann's application of the algorithms, not McKesson's programs.

Q. In the materials that you've reviewed, have you seen anywhere where McKesson has actually run their algorithm on their retrospective data to try to figure out what should have been flagged?

A. Again, I focused on Dr. McCann's application of these algorithms. I have not looked at how the distributors were running the programs.

Q. This is what has been affectionately referred to by me alone as the matrix. And it has pharmacies in Huntington/Cabell County, West Virginia.

Have you attempted to run any algorithm on the actual data from the pharmacies in Huntington/Cabell County, West Virginia?

A. I'm trying to process your question.

First of all, I have never seen that before, so I don't know what you're referring to. But what I've done is replicated Dr. McCann's application of these algorithms on ARCOS data, as well as the defendant distributor data.

To the extent that pharmacy shipments to a specific pharmacy you're referring to are in those data, then I have run Dr. McCann's application of the algorithms on those -- on shipments to those pharmacies.

MR. FARRELL: Go to the next slide, please. I'm sorry. From the defendants, the one with all of the months and the seats. It's like an arena. There we go.

BY MR. FARRELL:

Q. So do you recall talking about this, this particular slide? You understand how it's supposed to run, do you not?

A. There were two questions there. I do recall referring to this slide, yes.

Q. So, basically, the idea under the *Masters* methodology is you take a look at a period of time and you try to find an average; correct?

A. So, no. Dr. McCann's algorithm, what it does is looks at the maximum across the last six months, not the average.

Q. We'll use that. What's the maximum here for the last six weeks or six months in this, in this example?

A. As I said earlier, it's 10,000 from February, 10,000 dosage units from February.

Q. And, so, if there are sales in excess of 10,000, it's supposed to trigger something. Agreed?

A. Just to be clear, the way the algorithm works is if the cumulative shipment volume within a month exceeds the maximum monthly shipments from any of the prior six months, then that shipment is flagged and shipments for the remaining, remainder of the month are flagged.

Q. Perfect. So once you reach some threshold, it's supposed to be flagged. Agreed?

A. That's what the algorithm does, yes.

Q. Okay. So what's supposed to happen after the flag?

A. The algorithm moves to the next month and evaluates the shipments of that month against the prior six months. That's what the algorithm does.

Q. I see. I see. What do the policies of McKesson say should be done after the flag?

A. Dr. McCann didn't review the policies --

Q. I'm not asking you that. What do the policies of McKesson say should be done after the flag?

A. That's not something I reviewed.

Q. Let me give you an example. Let's go to the very next one. The very next one is the one that, where you say this is what it should look like using this theoretical distribution month by month. Do you see this?

A. I see the chart.

Q. Okay. Have you made an attempt to run that same, same analysis to a pharmacy, say, in Logan County, West Virginia, that's averaging 180,000 pills a month?

A. Again, all I can say is to the extent that the pharmacies you're referring to are in Dr. McCann's data, then Dr. McCann has run his algorithm on those shipments. And I have also run Dr. McCann's algorithm on those shipments.

Q. Sir, let me ask you in a different way. If let's say in a small town of 400 people McKesson is selling 100,000 prescription opioids a month and an algorithm flags it and says something's going on here. Should McKesson still be able to ship 100,000 every month thereafter? Is that your opinion?

A. I don't have an opinion about that. That's not something that I have expertise on.

Q. Your testimony was that the DEA estimates that .1 percent of prescription opioids are being diverted. Are you taking that information from the congressional testimony that 99.99 percent of doctors are trying to do the good thing? Is that where you're getting that data from?

A. No.

Q. Where are you getting that from?

A. As I testified, and as I specified in my report, I went to the DEA's website where they publish their estimates of diversion out of the controlled channel of a number of drugs, and they publish that in kilograms.

And I took their estimate of diversion out of the controlled channel and I divided by total shipments to come up with an estimate of what fraction of shipments are then diverted out of the controlled channel.

Q. Where does the DEA get this from?

A. That's something that the DEA does. I don't have -- I'm not an expert on how the DEA estimates its diversion out of the controlled channel. But that's one of the things that it's obligated to do and one of the things that it does each year.

Q. You understand that there have been no less than 15 DEA agents who have been deposed in this case and that's -- what

you've just said is nowhere in the record?

A. Is that a question?

Q. Yes. Do you understand that that is nowhere in the record in this case?

A. I have not reviewed the entire record of this case, so I wouldn't know that.

Q. So let me just take one particular example and see if we can get there. And I'm going to take the most ridiculous of examples as I can.

Do you know where Mingo County, West Virginia, is?

A. I do not.

Q. In Mingo County, West Virginia, let's just --

THE COURT: Just a minute, Mr. Farrell.

Ms. Wu.

MS. WU: Your Honor, just for the record, we object based on geographic scope. And if we're going to continue, I'd ask for a running objection. But I don't think this is appropriate or relevant.

THE COURT: Well, I'll let him -- he's using it as an example. I'll let him go ahead and do it.

BY MR. FARRELL:

Q. In Mingo County, West Virginia, if 268,000 doses of hydrocodone are sold in one month to one pharmacy, is it your testimony that only .1 percent of those are being diverted?

A. No. My testimony is that the DEA estimates that, that the level of diversion out of the controlled channel of oxycodone, hydrocodone in 2018 and '19 is consistent with about .1 percent of shipment volumes being diverted out of the controlled channel.

Q. Last question, Doctor. This is an exhibit in this case and it demonstrates a volume of pills that were sold into the geographic region of Huntington/Cabell County, West Virginia.

Based on your knowledge of algorithms to detect suspicious orders, would you expect that any of these orders, any of these shipments to be suspicious?

A. Well, it's zip code 255 and 257 which is not the same as Huntington and Cabell County.

Q. Let's just ignore anything but the pattern. Is there anything suspicious about this pattern of the sale of prescription opioids?

A. How do you want me to interpret the word "suspicious" there?

Q. Well, you've testified today -- you're here today talking about algorithms to detect suspicious orders. So we'll use whatever, whatever measure you want to use. Let's just use the broader one, "suspicious." Is there anything suspicious about this demonstrative?

A. Well, the only context I have for suspicious in this

case is Dr. McCann's use of the word "suspicious" to characterize the results of his application of algorithms to the ARCOS data of shipments into Huntington and Cabell County, West Virginia.

Q. All right.

A. So I have not run his, his algorithms on those data, but I have run them on, on shipments into Cabell County and Huntington, West Virginia.

Q. If this is the sale of beer in Huntington, Cabell County, West Virginia, is there anything suspicious about this pattern?

A. I don't think I can answer the question. I don't have a definition of "suspicious" with respect to beer shipments.

Q. If this was machine guns sold into West Virginia, is there anything suspicious about this pattern?

A. Again, same thing. Suspicious as defined by Dr. McCann relates back to the, the Suspicious Order Monitoring Programs and his use of the algorithms applied to ARCOS data. So that's the context in which I think I, I would use the term "suspicious" here.

Q. Let me try one last time. If this is the number of home runs that were hit in a major league baseball season and you looked at this over time, would you find anything suspicious about this pattern?

A. Again, same thing. This is -- you know, the purpose of

talking about suspicious to me is -- relates back to Dr. McCann. He's the one who uses the word "suspicious." I'm simply looking at Dr. McCann's application of algorithms where he's flagging 72 percent of shipments as suspicious and unlawful and assessing whether that makes any sense.

MR. FARRELL: Thank you. No further questions, Judge.

THE COURT: Any redirect, Ms. Wu?

MS. WU: Nothing further. Thank you.

THE COURT: May Dr. Boberg be excused?

MR. FARRELL: Yes, Your Honor.

THE COURT: Thank you, Dr. Boberg. You're free to go. Thank you, sir, very much.

THE WITNESS: Thank you very much, Your Honor.

MS. MAINIGI: So, Your Honor, I think that's the extent of our witnesses for today. As I mentioned, we have a Cardinal witness similar to the prior two witnesses. He had a -- he had prior testimony scheduled for today. So we can put him on first thing in the morning.

THE COURT: Will he be here first thing in the morning?

MS. MAINIGI: He will be here first thing in the morning. He's actually here. He's doing that testimony by Zoom right now. So he's, he's in town.

THE COURT: I'm sorry. I interrupted you. You go

ahead.

MS. MAINIGI: And that will be our only witness tomorrow. So just in terms of the amount of time that would take, probably somewhat comparable.

THE COURT: Okay. Well, we'll start at 9:00 in the morning.

Is there anything else to do today before we adjourn?

(No Response)

THE COURT: Hearing none, I'll see everybody at 9:00.

MS. MAINIGI: Thank you.

(Trial recessed at 3:46 p.m.)

CERTIFICATION:

I, Ayme A. Cochran, Official Court Reporter, and I, Lisa A. Cook, Official Court Reporter, certify that the foregoing is a correct transcript from the record of proceedings in the matter of The City of Huntington, et al., Plaintiffs vs. AmerisourceBergen Drug Corporation, et al., Defendants, Civil Action No. 3:17-cv-01362 and Civil Action No. 3:17-cv-01665, as reported on July 8, 2021.

S\Ayme A. Cochran
Reporter

s\Lisa A. Cook
Reporter

July 8, 2021
Date

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